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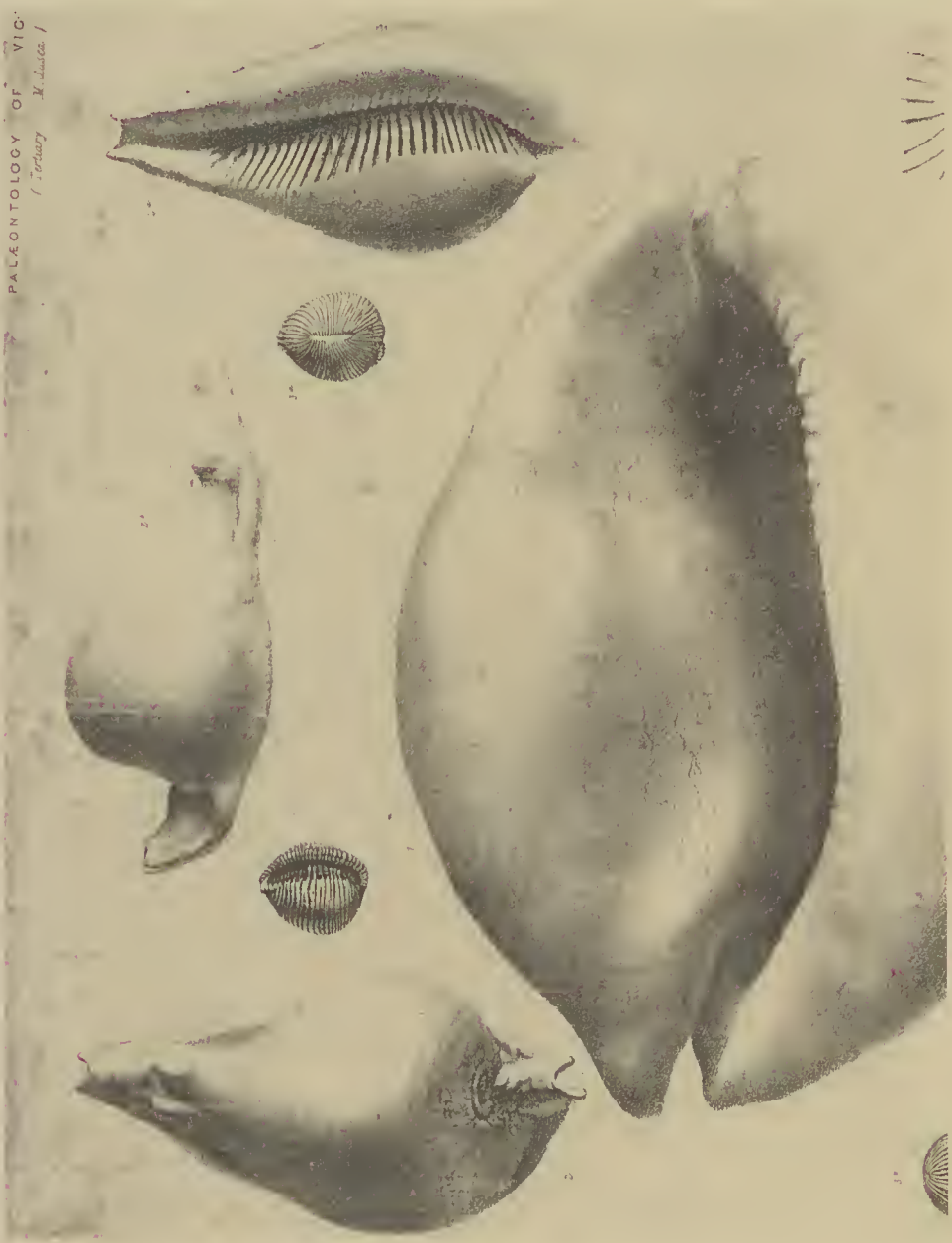

Front cover: Plates 28 and 29 of Frederiek McCoy's *Prodromus of the Palaeontology of Victoria*, showing *Umbilia eximia* (Sowerby), *Trivia avellanoides* McCoy and *Zoila gigas* (McCoy), species reexamined by T. Darragh in this issue of the *Memoirs*.

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The *Memoirs* publishes papers on original research in the natural sciences pertinent to Victoria and/or the Museum's collections. All contributions are assessed by independant referees before publication.

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Papers should be arranged as follows: title (including higher classification of zoological taxa); authors' names and addresses (postal and email); abstract; contents (only if the paper is very long); introduction and main text; acknowledgements; references; index (only if very long); and tables. Captions to text-figures and plates must be attached to the manuscript as final pages. Primary headings are in bold and centred; secondary headings in italics and left justified. Italics in the text should otherwise be restricted to generic and specific names. Paragraphs are indented with tabs. Measurements must be in the metric system (SI units).

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Paulin, C.D., 1986. A new genus and species of morid fish from shallow coastal waters of southern Australia. *Memoirs of the Museum of Victoria* 47: 201–206.

Last, P.R. and Stevens, J.D., 1994. *Sharks and rays of Australia.* CSIRO: Melbourne. 513 pp.

Wilson, B.R. and Allen, G.R., 1987. Major components and distribution of marine fauna. Pp. 43–68 in: Dyne, G.R. and Watson, D.W. (eds). *Fauna of Australia. General articles.* Vol. 1A. Australian Government Publishing Service: Canberra.

Reference citations use the following style: Paulin, 1986; Last and Stevens, 1994; Smith et al., 1990.

In taxonomic papers synonymies should be of the form: taxon, author, year, pages, figures. A period and dash must separate taxon and author

except in the case of reference to the original description, e.g.,

Leontocaris Stebbing, 1905: 98–99.—Barnard, 1950: 699.

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Supplementary information (extended lists of material examined, databases etc.) should be submitted electronically with the original manuscript and will be included with material sent to referees. The Editorial Board encourages use of supplementary information to minimise the cost of printing as long as the requirements of the International Code of Zoological Nomenclature are met in the printed paper.

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Memoirs of Museum Victoria 59(2): 277–296 (2002)

NEW GENUS AND SPECIES OF SOUTHERN AUSTRALIAN AND PACIFIC ASTERINIDAE (ECHINODERMATA, ASTEROIDEA)

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Abstract

O'Loughlin, P.M., 2002. New genus and species of southern Australian and Pacific Asterinidae (Echinodermata, Asteroidea). *Memoirs of Museum Victoria* 59(2): 277–296.

The diagnostic characters of the Asterinidae species *Asterina atyphoida* H.L. Clark from southern Australia and *Asterina gibbosa* (Pennant) from the Atlantic, type species of *Asterina* Nardo, are reviewed. *Asterina atyphoida* is referred to *Meridiastra* gen. nov., with four other species: *Meridiastra fissura* sp. nov. and *Meridiastra nigranota* sp. nov. from southern Australia, *Meridiastra rapa* sp. nov. from the central south Pacific, and *Meridiastra modesta* (Verrill) from the Pacific coast of Panama and Mexico. *Asterina agustincasoi* Caso is synonymised with *Meridiastra modesta* (Verrill). *Asterinides* Verrill is recognised as a valid genus. *Meridiastra fissura* is fissiparous. *Meridiastra* is distributed from southern Australia to the Pacific coast of Mexico and Panama. A key is provided for the species of *Meridiastra*.

Introduction

Rowe (in Rowe and Gates, 1995 and in a note in Campbell and Rowe, 1997) considered that species of the Asterinidae from Australian waters which were assigned to the genus *Asterina* Nardo, 1834 were not congeneric with the type species *Asterina gibbosa* (Pennant, 1777), and required reassignment to an existing or new genus. Rowe and Berents (in an unpublished draft manuscript, cited in this work as pers. com.) anticipated assigning one of these species, *Asterina atyphoida* H.L. Clark, 1916, to a new genus together with a new fissiparous southern Australian species. This anticipated genus is established here, and a second new species from southern Australia is included. The remaining Australian species assigned to *Asterina* are not reallocated to this new genus, and their reassignment is not treated in this work.

Marsh (1974) reported an *Asterina* sp. from Rapa I. in the South Pacific, and this species is described below and assigned to the new genus. The eastern Pacific species *Asterina agustincasoi* Caso, 1977 and *Asterina modesta* Verrill, 1870 are synonymised, and *A. modesta* is reassigned to the new genus.

Rowe and Berents (pers. com.), in their anticipated review of the genera of the Asterinidae, considered that the presence or absence of superambulacral internal plates, the internal alignment of abactinal and actinal plates towards the body margin, and the arrangement of cleared actinal plates were helpful in distinguishing the genera. These diagnostic features are included in the descriptions below, without judgement as to their significance. Clark and Downey (1992) used the first two of these characters in their diagnosis of *Asterina*, referring to an absence of superambulacral plates and to the reinforcement of the ventrolateral angle by an internal overlapping of the adjacent abactinal and actinal plates often with additional plates, but did not describe the arrangement of actinal plates. In this study the arrangement of cleared actinal interradial plates was found to be inconsistent for a specimen and a species, and the apparent arrangement on uncleared specimens was sometimes different to that revealed on cleared specimens of the same species. For *Asterina gibbosa* the actinal series on one uncleared specimen appeared to curve at an acute angle distally from furrow to margin (Fig. 1e), while on a cleared specimen the series curved obliquely (obtusely) from furrow to margin (Fig. 1f).

Verrill (1913) reassigned *Asterina modesta* to his new genus *Asterinides* Verrill, 1913. Fisher (1919) synonymised *Asterinides* with *Asterina*. A.M. Clark (1983) and Clark and Downey (1992)

considered that *Asterinides* (type species *Asteriscus foliuin* Lütken, 1860, from the West Indies) could be revived from its synonymy with *Asterina* and recognised at least as a valid subgenus. Rowe (in Rowe and Gates, 1995 and in a note in Campbell and Rowe, 1997) supported the recognition of *Asterinides* as a valid genus. Rowe and Berents (pers. com.) considered that their anticipated new genus, described below, was close to *Asterinides*, but distinguished the two genera. *Asterinides* is recognised below as a valid genus, but not the appropriate genus for *Asterina modesta*.

Molecular phylogeny studies of Asterinidae species, such as by Byrne et al. (1999), are providing further evidence on which to review the assignment of species to the many existing Asterinidae genera. In the current absence of adequate molecular evidence a review of the assignment of species to *Asterina* and *Asterinides* is not undertaken here.

Terminology here follows that defined in the glossary and illustrated in Figs 2 and 3 of Clark and Downey (1992), except that "papular space" is used for "papular area" ("restricted area with papular pores") and "papulate areas" is used to refer to the parts of the abactinal surface where papulae occur. "Ad-disc" refers to a location adjacent and distal to the plates bordering the disc.

Abbreviations of institutions are as follows: AM, Australian Museum, Sydney, Australia; BPBM, Bishop Museum, Honolulu, USA; ICML-UNAM, Instituto de Ciencias del Mar y Limnologia, Universidad Nacional Autonoma de Mexico, Mexico; MCZ, Museum of Comparative Zoology, Harvard University, Massachusetts, USA; NMV, Museum Victoria, Melbourne, Australia; NTM, Northern Territory Museum, Darwin, Australia; SAM, South Australian Museum, Adelaide, Australia; TM, Tasmanian Museum, Hobart, Australia; USNM, Museum of Natural History, Smithsonian Institution, Washington, USA; WAM, Western Australian Museum, Perth, Australia; YPM, Peabody Museum of Natural History, Yale University, Connecticut, USA; ZMUC, Zoological Museum, University of Copenhagen, Denmark.

Asterinidae Gray, 1840

Asterina Nardo, 1834

Synonymy. See Clark and Downey (1992: 177).

Type species. Asterina gibbosa (Pennant, 1777)

Diagnosis. See Clark and Downey (1992: 177).

Remarks. Rowe (in Rowe and Gates, 1995) listed nine Asterinidae species from Australian waters which were assigned to *Asterina: A. alba* H.L. Clark, 1938 from the Tasman Sea; *A. anomala* H.L. Clark, 1921 from Torres Strait; *A. atyphoida* H.L. Clark, 1916 from southern Australia; *A. cepheus* (Müller and Troschel, 1842) from northern Australia; *A. coronata* von Martens, 1866 from northern Australia; *A. heteractis* H.L. Clark, 1938 from the Tasman Sea; *A. inopinata* Livingstone, 1933 from eastern Australia; *A. sarasini* (de Loriol, 1897) from northern Australia; and *A. scobinata* Livingstone, 1933 from south-eastern Australia. Rowe (in Rowe and Gates, 1995) considered that these species assigned to *Asterina* were not congeneric with the type species *Asterina gibbosa* (Pennant, 1777) and required reassignment to an existing or new genus. Of the above nine species only *Asterina atyphoida* H.L. Clark is assigned here to a new genus. None of the remaining eight species is congeneric with *A. atyphoida* (pers. obs. of AM specimens of all species). Possible reassignment of these eight species is not undertaken in this work. Rowe (in Rowe and Gates, 1995) considered that the genus *Asterina* might be restricted to Atlantic waters.

With the description of a new genus below and inclusion of two species previously assigned to *Asterina*, and the raising below of *Asterinides* out of synonymy with *Asterina*, the diagnosis of *Asterina* requires emendment. But a re-examination of the many species currently assigned to *Asterina* should be appropriately undertaken when the emerging molecular evidence is adequate, and an emended diagnosis is not given here.

Asterina gibbosa (Pennant, 1777)

Figures 1a–f, 7f

Synonymy. See Clark and Downey (1992: 184).

Material examined. Atlantic Ocean, European seas (no other data), AM J1250 (1); Ireland, Co. Down, Granagh Bay, 5 Aug 1959, NMV F87241 (3); Wales, Gwynedd, Anglesey, Rhosneigr, under rocks, 28 Sep 1971, NMV F87242 (5). Mediterranean Sea, France, Marseilles, Jun 1978, AM J 12408 (3); Italy, Bay of Naples, AM G11524 (2); donation from Naples Aquarium, 1890, NMV F45108 (3); Mediterranean (no other data), AM G7575 (2).

Diagnosis. See Clark and Downey (1992: 184–185).

Remarks. Asterina gibbosa material examined in this study differed in minor ways from the diagnosis by Clark and Downey (1992), and these differences and additional observations are noted. The first five radials involved in forming a pentagon bordering the disc were separated by single

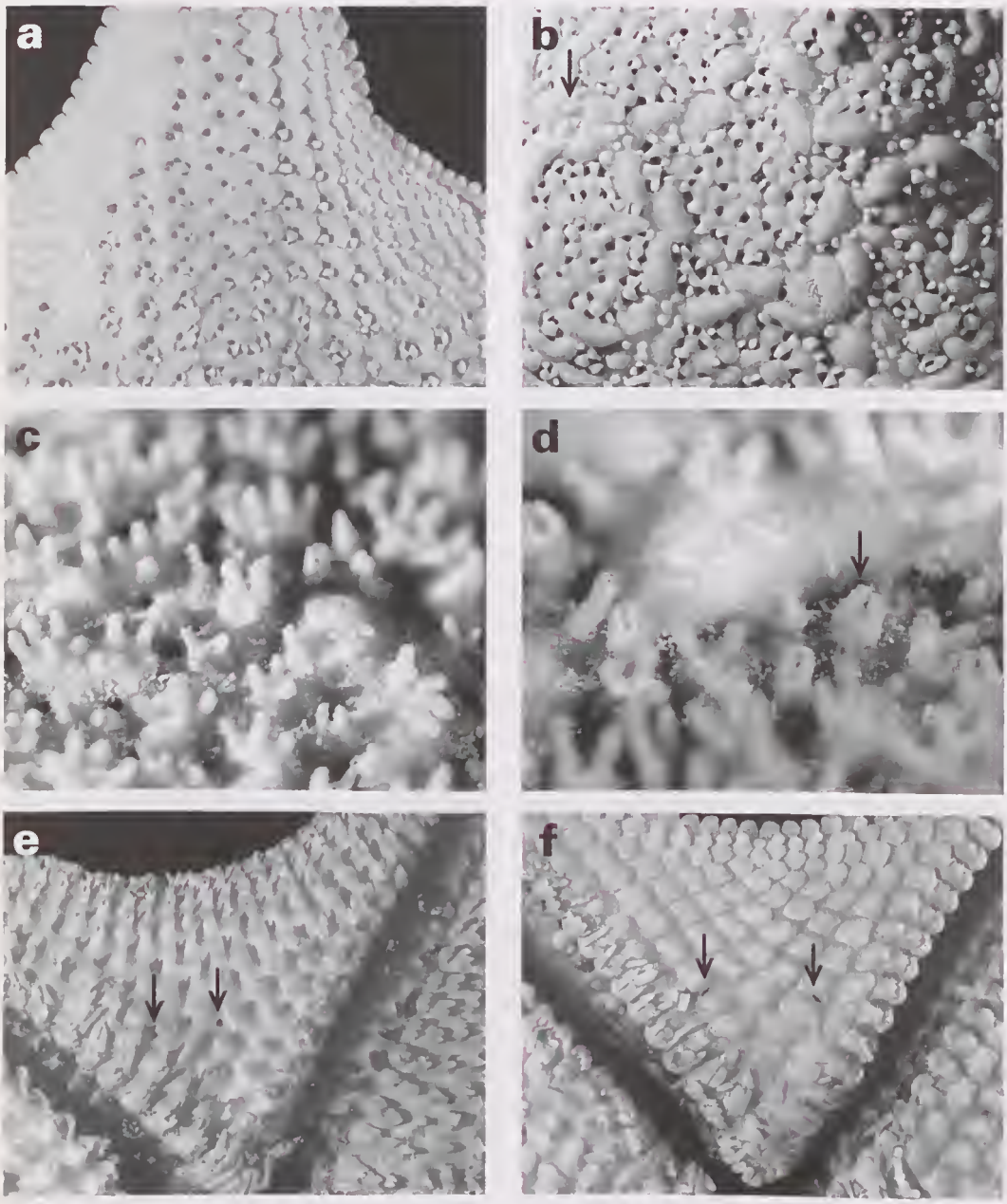

Figure 1. *Asterina gibbosa* (Pennant) (Mediterranean specimens, lot NMV F45108). a, cleared abactinal ray (R = 19 mm); b, cleared disc and madreporite (lower right), with one non-papular proximal interradius (arrow); c, abactinal spinelets (0.3 mm long); d, abactinal pedicellariae (one at arrow, 0.25 mm long); e, actinal interradius with gonopores (arrows); f, cleared actinal interradius, with plates in series curving obliquely from furrow towards margin, and with gonopores (arrows).

interradial plates. Papulate areas were more extensive than non-papulate areas. The madreporite was oval to lobed, not triangular. A carinal series of plates in the mid-third of each ray was distinct, the carinals typically separated by pairs of secondary plates. Secondary plates numbered up to six in some pore areas. The superomarginals were the smallest of the abactinal interradial plates, were generally aligned with the proximal edge of the projecting inferomarginals, and were interspersed with varying numbers of secondary plates. Associated with the distinctive disc there were four ad-disc triangular interradial papular spaces each with more than two secondary plates and more than two papulae (fifth space occupied predominantly by the madreporite), and distal to these were five interradial areas which had secondary plates and pedicellariae but which lacked papulae and spines. There were some conspicuous glassy convexities around the margin but not on the crown of abactinal plates. Abactinal spinelets were typically 0.3 mm long. There were clusters of up to 6–8 papular pores. Suboral spines were noticeably tall, and some plates had up to three. The first row of actinal adradial plates bore a complete series of typical actinal spines. There was an irregular series of secondary plates at the actinal edge of the inferomarginal series. There were no internal superambulacral plates, but there were internal tapered contiguous projections on the distal actinal and abactinal interradial plates giving structural support to the ventrolateral angle. Cleared actinal interradial plates curved in oblique (obtuse) series from the furrow to the margin.

Meridiastra gen. nov.

Type species. Asterina atyphoida H.L. Clark, 1916

Diagnosis. Small, up to R = 13 mm; R/r = 1.2–1.3; rays 5 (6–8 in fissiparous species), ends rounded, interradial margins straight or slightly incurved; pentagonal or near-pentagonal if 5-rayed; body flat orally, thin, acute angle at margin, body slightly domed or low pyramidal aborally; pedicellariae absent; triangular madreporite.

Abactinal plates closely imbricating, in regular series; disc poorly defined or not distinct; papular spaces small; projecting plates fan-shaped, except radially, never predominantly crescentic or deeply notched; papulate areas smaller than non-papulate areas; papulae few, proximal, predominantly radial, mostly single; abactinal plates granular, covered with glassy convexities; abactinal plates with readily-detached glassy spinelets, smaller than 0.3 mm long, across free margin on proximal plates, not in tufts on proximal plates; superomarginal plates not extending to margin, generally aligned with proximal edges of projecting inferomarginals; lacking superambulacral internal plates; distal actinal and abactinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, with distal fine spinelets forming marginal fringe; actinal plates in regular series; actinal interradial plates with 1–3 spines; adambulacral plates with 1–2 subambulacral spines, 2–3 webbed adambulacral (furrow) spines.

Species. Meridiastra atyphoida (H.L. Clark, 1916); *M. fissura* sp. nov.; *M. modesta* (Verrill, 1870); *M. nigranota* sp. nov.; *M. rapa* sp. nov.

Etymology. From the Latin *meridies* (south) with *astrum* (star), referring to the southern Australian and Pacific occurrence of this seastar genus (feminine).

Distribution. From southern Western Australia to the Pacific coasts of Mexico and Panama; 0–59 m.

Remarks. Rowe (in Rowe and Gates, 1995) considered that *A. atyphoida* was not congeneric with *A. gibbosa*, the type species of *Asterina*, and this judgement is supported here. The combination of characters distinguishing the *Asterina* type species, *A. gibbosa*, and *Meridiastra* are listed in Table 1. The diagnostic distinctions between *Meridiastra* and the *Asterinides* type species, *A. folium*, are listed in Table 3. Distinguishing characters are evident in small to large specimens.

Key to species of *Meridiastra*

1. Arms 6–8, form irregular (post fissipary); more than 1 madreporite; fissiparous; only distal abactinal plates in regular series..... ..... *Meridiastra fissura* sp. nov.
— Pentagonal form; single madreporite; not fissiparous; abactinal plates in regular series 2

2. Secondary plates numerous proximally; abactinal gonopores each with 1–3 proximal spinous secondary plates; actinal interradial plates with predominantly 2 spines ..... *Meridiastra modesta* (Verrill, 1870)
— Secondary plates rare or absent proximally; abactinal or actinal gonopores lacking secondary plates; actinal interradial plates with predominantly 1 spine..... 3
3. Disc not distinct; proximal carinal series very irregular, extending less than half ray length; actinal adradial row of interradial plates with complete series of spines.....*Meridiastra rapa* sp. nov.
— Disc distinct; regular proximal carinal series extending three quarters ray length; actinal adradial row of interradial plates with spines irregularly present or lacking 4
4. Gonopores abactinal; abactinal spinelets predominantly in single series on proximal plate edge; subambulacral spines predominantly single; single suboral spine frequently present; live colour variable cream, yellow, orange, mauve, red, brown .....*Meridiastra atyphoida* (H.L. Clark, 1916)
— Gonopores actinal; abactinal spinelets frequently in irregular double series on proximal plate edge; subambulacral spines predominantly paired; suboral spines rarely present; live colour white with small black spots abactinally..... .....*Meridiastra nigranota* sp. nov.

Meridiastra atyphoida (H.L. Clark) comb. nov.

Figures 2a–f

Asterina atyphoida H.L. Clark, 1916: 57, pl. 17.—H.L. Clark, 1928: 389.—Cotton and Godfrey, 1942: 201.—H.L. Clark, 1946: 130.—A.M. Clark, 1966: 324–325.—Shepherd, 1968: 745.—Dartnall, 1970a: 73.—Dartnall, 1980: 34, map 6(1).—Zeidler and Shepherd, 1982: 411–412, fig. 10.6(d).—Rowe and Vail, 1982: 222.—O'Loughlin, 1984: 134.—Clark, A.M., 1993: 207.—Marsh and Pawson, 1993: 281 (part, Esperance specimens).—Rowe (in Rowe and Gates), 1995: 34.—Edgar, 1997: 344–345.

Material examined. Holotype. South Australia, 15 miles NW of Cape Jervis, 31 m, AM E6303.

Paratypes. Kangaroo I., off Cape Marsden, 30 m, AM E859 (2).

Other material (selection for distribution and depth range). Victoria, East Gippsland Scallop Survey St. 41, 38°50'S, 147°41'E, 22 m, 28 Jan 1971, NMV F73005 (2); Port Albert, donated 23 May 1906 (no other data), NMV F71937 (1); San Remo, 1 Apr 1990, NMV F58684 (2); Crib Point, 15 m, 12 Aug 1970, NMV F71939 (3); Shoreham, 20 Aug 1972, TM H1841 (1); Flinders ocean platforms, 12 Dec 1993, NMV F87229 (1); Port Phillip Bay, Portsea Jetty, 5 m, May 1975, AM J9246 (1); Portland, Saxon Reef, 11 m, 5 Mar 1992, NMV F87235 (1). Tasmania, Tamar River, Greens Beach, 13 Jul 1969, TM H1059 (1); Deal I., East Cove, 5 m, 4 May 1974, AM J16573 (1); Erith I., 21 m, 1974, NMV F87160 (1); Bass Strait Survey St. 138, off Flinders I., 52 m, 6 Feb 1981, NMV F87228 (9); St. 160, off Deal I., 59 m, 13 Nov 1981, NMV F87236 (1). South Australia [SA material referred to by H.L. Clark (1916, 1928): SAM K103 (1), K104 (6), K105 (1), K1878 (6), K1879 (14)]; Victor Harbour, 5 m, 2 Apr 1980, NMV F87168 (1); Kangaroo I., The Pages, NE of Cape Willoughby, 27 m, 12 Apr 1941, SAM K1890 (1); Cape Jervis Jetty, 2 m, 9 Mar 1984, SAM K1887 (1); Investigator Strait, 15 Jan 1971, NMV F87163 (2); Yorke Peninsula, Edithburgh Jetty, 3–4 m, 10 Sep 1995, SAM K1872 (1); Sir Joseph Banks Group, Lusby I., 6 m, 11 Jan 1984, SAM K1885 (2); Port Lincoln, 19 Mar 1968, NMV F87233 (1); Elliston, 18 m, 12 May 1971, NMV F87158 (1); Nuyts Archipelago, Franklin I., 6–8 m, 15 Apr 1983, SAM K1871 (1); Point Sinclair, 10 May 1973, NMV F87161 (3). Western Australia, Esperance, between Sandy Hook I. and Cape Le Grand, 31–35 m, 23-25 Jun 1986, WAM Z6855 (5).

Description of material. Small, up to R = 13 mm; form pentagonal, interradial edges straight, sometimes near-pentagonal with interradial margins incurved, typically R/r = 1.3; rays 5, rarely 6, ends rounded; body flat orally, thin, slightly domed or low pyramidal aborally, acute angle at margin; single triangular madreporite; not fissiparous; pedicellariae absent; paired interradial gonopores abactinal.

Abactinal plates closely imbricate, in regular series; papular spaces small; papulate areas less extensive than non-papulate areas; secondary plates rare, disc and margin only, never separating carinal plates; disc variably distinct, bordered by irregular pentagon comprising 5 proximal carinal and 5 interradial plates; each radius with 5 longitudinal series of plates in mid-ray; distinct proximal carinal series comprises up to 10 (rarely 11) plates extending three quarters of ray length, distally typically 6 (up to 14) zig-zag radial plates; carinals with proximal edge slightly convex or straight or concave, some with slight median lobe; some radials indented proximally for 1 or rarely 2 papulae; projecting interradial plates

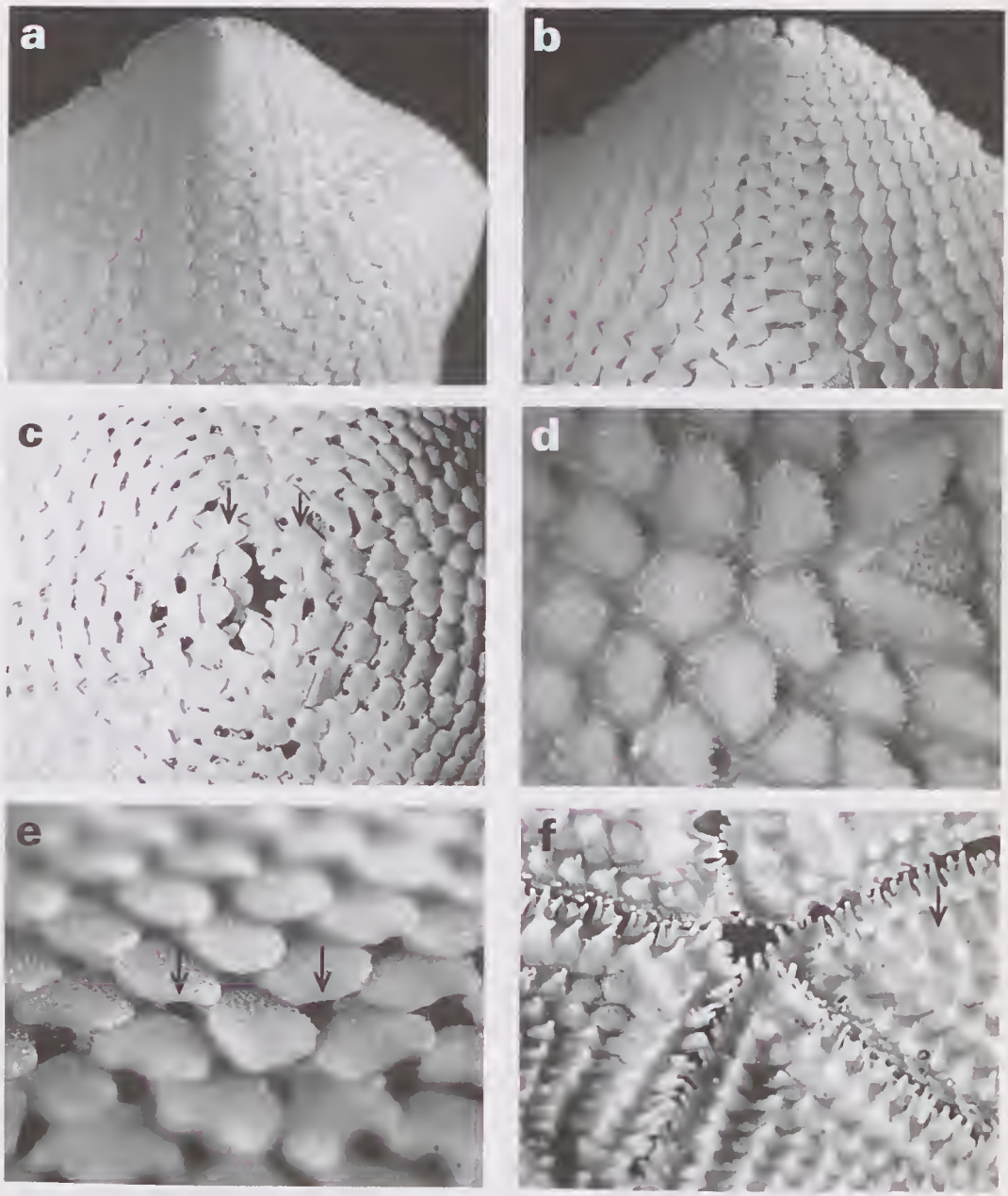

Figure 2. *Meridiastra atyphoida* (H.L. Clark) comb. nov. a, abactinal ray and interradii (R = 10 mm) (NMV F87229); b, cleared abactinal ray and interradii (R = 11 mm) (NMV F45092); c, cleared proximal abactinal plates, madreporite (lower right of disc), and indistinct disc (arrows at two proximal carinal plates) (NMV F45092); d, abactinal plates with spinelets (0.1 mm long), glassy convexities, and madreporite (upper right) (NMV F73465); e, cleared abactinal interradial plates with two gonopores (arrows) (NMV F45092); f, proximal actinal view, with absence of spines on adradial actinal plates (arrow) (NMV F87229).

fan-shaped; abactinal plates granular, covered with conspicuous glassy convexities; plates with commonly up to about 10 (rarely up to 20) fine bluntly-pointed readily-detached glassy spinelets, up to 0.15 mm long, mostly across proximal edge in irregular single transverse series, rarely over plate, decreasing in number distally; papulae small, mostly single, on proximal two-thirds of radial areas, in proximal third only of carinal series, up to 6 longitudinal series in mid-ray, few on proximal interradial areas; superomarginals not extending to margin, generally aligned with proximal edge of projecting inferomarginals, each with up to 6 vertical spinelets on projecting crown of plate; some secondary plates proximal to superomarginal series; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with marginal fringe of 6–7 distal fine spinelets, typically 0.25 mm long, proximal transverse row of shorter spinelets (typically 5); some secondary plates at actinal edge of inferomarginal series; cleared actinal plates in regular series, curving acutely from furrow to margin or perpendicular to furrow; actinal interradial plates with 1 spine, rarely 2 in mid-interradius, 1–3 very small spines distally; adradial row of actinal interradial plates lacking spines; adambulacral plates with 1 thick to tall subambulacral spine (sometimes 2 in mid-ray and distally), 3 (rarely 4) webbed furrow spines (2-1 distally); oral spines 4–6 (commonly 5); 1 suboral spine frequently present on every oral plate, rarely none.

Live colour. Aboral colour varies, uniform or spotted or mottled, with white, pale brown, pink, red, red-brown, red-orange, mauve, yellow; disc and ends of rays dark grey-green to black; orally white with some irregular orange to reddish-brown flecking (Victorian specimens). Shepherd (1968) reported pale cream, yellow or light brown for South Australian specimens.

Distribution. Southern Australia, East Gippsland, Victoria, to Esperance, Western Australia; Bass Strait coast of Tasmania; 0–59 m.

Remarks. Material from Rottnest I., Western Australia, reported by Marsh and Pawson (1993) as *A. atyphoida*, and a single specimen from Flinders, Victoria, reported by Dartnall (1970b) as *A. atyphoida*, are the closely related *M. nigranota* described below. No evidence was found to confirm a distribution of *M. atyphoida* as far west as Rottnest I., as reported by Rowe (in Rowe and Gates, 1995). Nor was evidence found to confirm a distribution as far south as SE Tasmania, as reported by Dartnall (1980). Within *Meridiastra* the combination of diagnostic characters which distinguish *M. atyphoida* are the pentagonal form; long regular proximal carinal series of plates extending more than half the ray length; absence of proximal secondary plates except rarely within the disc; absence of spines on the adradial actinal plates; predominantly single subambulacral spines; frequent presence of suboral spines; and abactinal gonopores.

Meridiastra fissura sp. nov.

Figures 3a–f

Material examined. Holotype. Victoria, Flinders, ocean platforms, sublittoral rocky shallows, M. O'Loughlin and J. Ortenburg, 9 May 1993, NMV F87157.

Paratypes. Type locality, 16 Nov 1980, NMV F71878 (1); 13 Apr 1985, NMV F86021 (7); 5 Oct 1991, NMV F87227 (1); 22 Feb 1992, NMV F71880 (1); 12 Apr 1993, NMV F71879 (3); 12 Dec 1993, NMV F86019 (1).

Other material (selection for distribution and depth range). New South Wales, Little Bay, Sydney, 17 Jun 2001, NMV F89161(1); Eden, Twofold Bay, Yallumgo Cove, 24 Nov 1984 (pers. obs.). Victoria, Cape Conran, 5–6 m, 15 Apr 1998, NMV F87155 (1); Waterloo Bay, 10 m, 27 Feb 1996, NMV F87066 (1); Venus Bay, Twin Reefs, 4 Mar 1982, NMV F71755 (1); Cape Paterson, 14 Feb 1981, NMV F87237 (1); Harmers Haven, 24 Feb 1983, NMV F71736 (2+2 cleared); Phillip I., Kitty Miller Bay, 8 Jan 1986, NMV F87411 (1); Cheviot Beach, 31 Mar 1998, NMV F87065 (14); Port Phillip Heads, 15 m, 1 Jul 1982, NMV F86022 (2); Portsea Jetty, 5 m, May 1975, AM J9243 (1); Torquay, Point Danger, 28 May 1982, NMV F87239 (1); Mullet Holes, 10 km NE Apollo Bay, 2 Jan 1988 (pers. obs.); Portland, 28 Feb 1992, NMV F71883 (4). Tasmania, Alonnah, 12 Jan 1989 (pers. obs.); Maria I., 30 m, 23 Apr 1985, NMV F86020 (1); Deal I., East Cove, 15 m, 26 Mar 1981, NMV F71877 (5+3 cleared). South Australia, Robe, 9 Jan 1990 (pers. obs.); Victor Harbour, 9 Nov 1988 (pers. obs.); Cape Jervis, 10 Nov 1988, NMV F87412 (1); Normanville, 11 Nov 1988 (pers. obs.); Point Labatt, under rocks, intertidal, 15 Jan 1976, AM J10867 (7). Western Australia, Cheyne Beach, Lookout Point, 10 Nov 1969, NMV F87238 (2); Perth, Garden I., 1–2 m, 10 Dec 1983, WAM Z9695 (3).

Description. Small, up to R = 9 mm; rays 6–8, frequently 7, ends rounded, interradial edges slightly incurved, typically R/r = 1.3; form frequently asymmetrical (post fissipary), rays may be 3–4; body flat orally, thin, slightly domed aborally, acute angle at margin; madreporites up to 4, inconspicuous; anal openings up to 5; fissiparous; pedicellariae absent; 1–2 gonopores in each abactinal interradius.

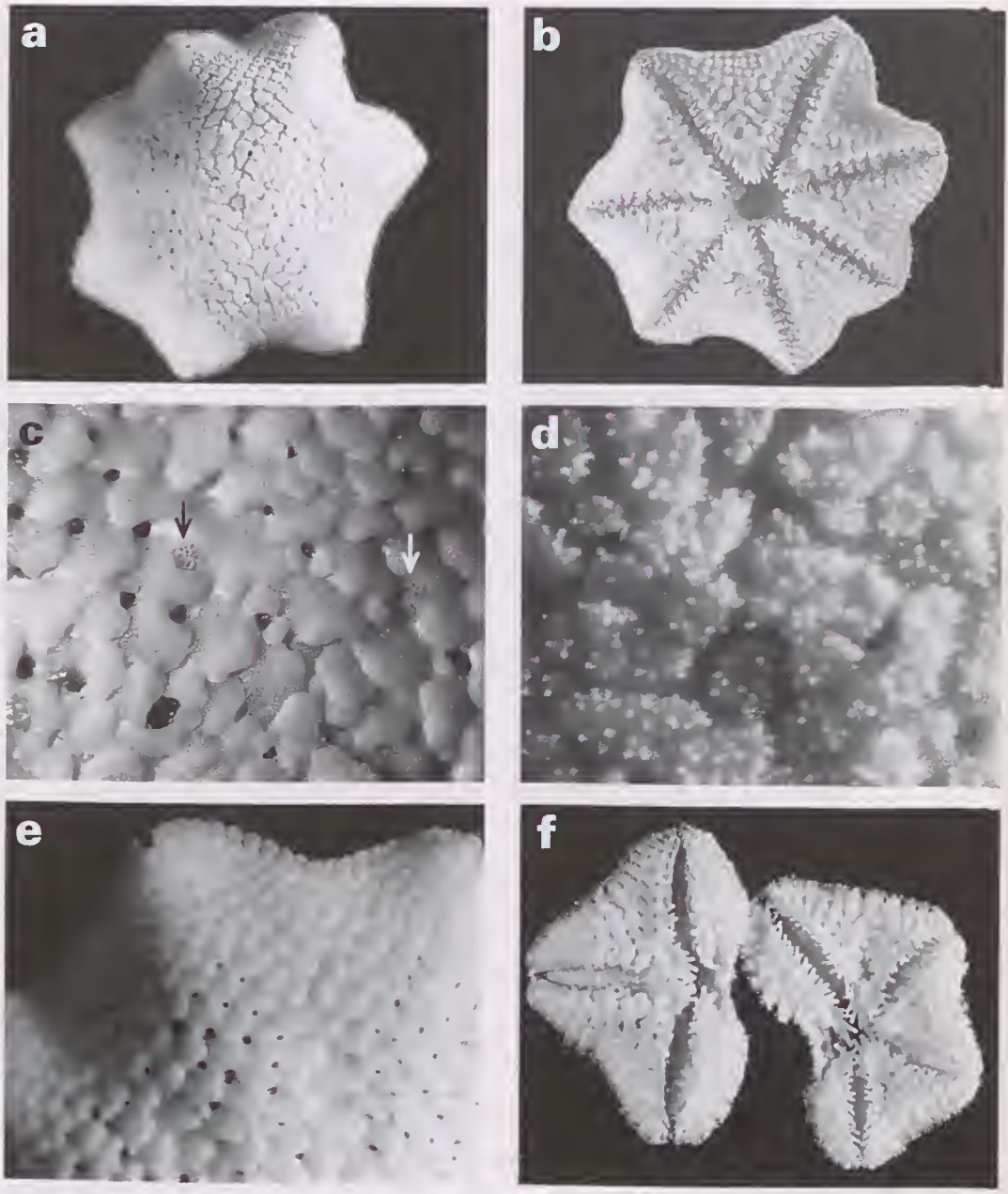

Figure 3. *Meridiastra fissura* sp. nov. a, abactinal view of holotype (R = 5 mm) (NMV F87157); b, actinal view of holotype; c, cleared proximal abactinal plates, and two madreporites (arrows) (NMV F71736); d, abactinal spinelets (0.1 mm long) (holotype); e, cleared abactinal rays and interradius (NMV F71736); f, actinal view of two specimens immediately after fissipary (NMV F87240).

Abactinal plates closely imbricate except proximally, in regular series distally only, in irregular mosaic proximally; papular spaces small; papulate areas similar in extent to non-papulate areas; secondary plates apically and distally, never separating carinals; lacking distinct disc; 5 longitudinal series of radial plates mid-ray; carinal series in mid-ray only; distal projecting abactinal plates fan-shaped, some radials with slightly concave proximal edge; size and form of proximal abactinal plates irregular; single (rarely paired) large papulae irregularly over proximal abactinal surface, absent from distal radial and interradial areas, proximal plates frequently slightly notched for single papula; abactinal plates granular, covered with fine glassy convexities; plates with up to about 30 small rugose frequently-webbed readily-detached glassy spinelets, typically 0.1 mm long, upright, scattered over plate, concentrated marginally, some plates with series on proximal edge pointing apically; superomarginals not extending to margin, generally aligned with proximal edges of projecting inferomarginals, some secondary plates along proximal edge of superomarginal series; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with marginal fringe of up to 7 distal fine spinelets, typically 0.2 mm long; non-calcareous actinal interradial areas proximally; cleared actinal interradial plates in regular series distally, curving acutely from furrow to margin; some secondary plates at actinal edge of inferomarginal series; actinal interradial plates frequently with 2–3 spines proximally; adradial row of actinal interradial plates with incomplete series of single often-reduced spines; adambulacral plates with 2 webbed subambulacral spines, 3 (rarely 4) webbed furrow spines; 6-4 oral spines; lacking suboral spines.

Live colour. Aborally faun to cream to white proximally, white distally, with a few irregular orange to red to dark reddish-brown spots, some spots brownish distally; madreporites yellow; rare dark greenish-black markings around ends of rays; some anal openings surrounded by dark greenish-black or red; white orally.

Distribution. Southern Australia, from Sydney (central New South Wales) to Garden I. (SW Western Australia); D'Entrecasteaux Channel, Alonnah (southern Tasmania); rock substrate, 0–30 m.

Etymology. From Latin *fissura* (split), referring to the fissiparous reproductive habit.

Remarks. This small species is fissiparous, and post-fissipary forms are frequently found. The number of arms (6–8), fissiparous habit, irregular form, multiple inconspicuous madreporites, very irregular proximal abactinal plates, and proximal abactinal spinelets not predominantly across the free margin of the plates distinguish this species and make it exceptional within the genus. But the small size, slightly incurved margins, distal abactinal plate arrangement, papular arrangement, small glassy readily-detached abactinal spinelets, actinal spination and absence of pedicellariae justify placement in *Meridiastra* rather than the establishment of a new monotypic Asterinidae genus.

Meridiastra modesta (Verrill) comb. nov.

Figures 4a–f

Asterina (Asteriscus) modesta Verrill, 1870: 277.

Asterinides modesta.—Verrill, 1913: 482.—Verrill, 1915: 61.

Asterina modesta.—Fisher, 1919: 410.—H.L. Clark, 1916: 57.—H.L. Clark, 1946: 130.—A.M. Clark, 1993: 211–212.

Asterina agustincasoi Caso, 1977: 209–231, figs 8–16, tbls 2–3 (syn. nov.)

Material examined. Asterina modesta. Lectotype (YPM 24175, alcohol). Panama, F.H. Bradley, 1866.

Paralectotypes. Type series, YPM 605A (3, dry, mounted); YPM 605B (3, alcohol); MCZ 776 (1, dry); Panama, Pearl I., F.H. Bradley, 1866, YPM 1536 (1, alcohol).

Other material. Panama, Panama Bay, Taboga I., Jun 1914, USNM 39110 (1).

Asterina agustincasoi. Paralectotypes. Type series, Mexico, Guerrero, 12 km W of Zihuatanejo, Ixtapa I., Jan 1963, ICML-UNAM 2.42.0 (9).

Description of material. Small, up to R = 10 mm; form pentagonal, interradial edges straight, sometimes near-pentagonal with interradial margins incurved, typically R/r = 1.2–1.3; rays 5, rarely 4, ends rounded; body flat orally, thin, slightly domed aborally, acute angle at margin; single triangular madreporite; not fissiparous; pedicellariae absent; paired interradial gonopores abactinal, under proximal edge of same or separate plates, with 1–3 proximal spinous secondary plates.

Abactinal plates closely imbricate, in regular series; papular spaces small; papulate areas less extensive than non-papulate areas; numerous secondary plates proximally, 1-5 in papular spaces radially and interradially, frequently between carinal plates, proximal to abactinal gonopores in

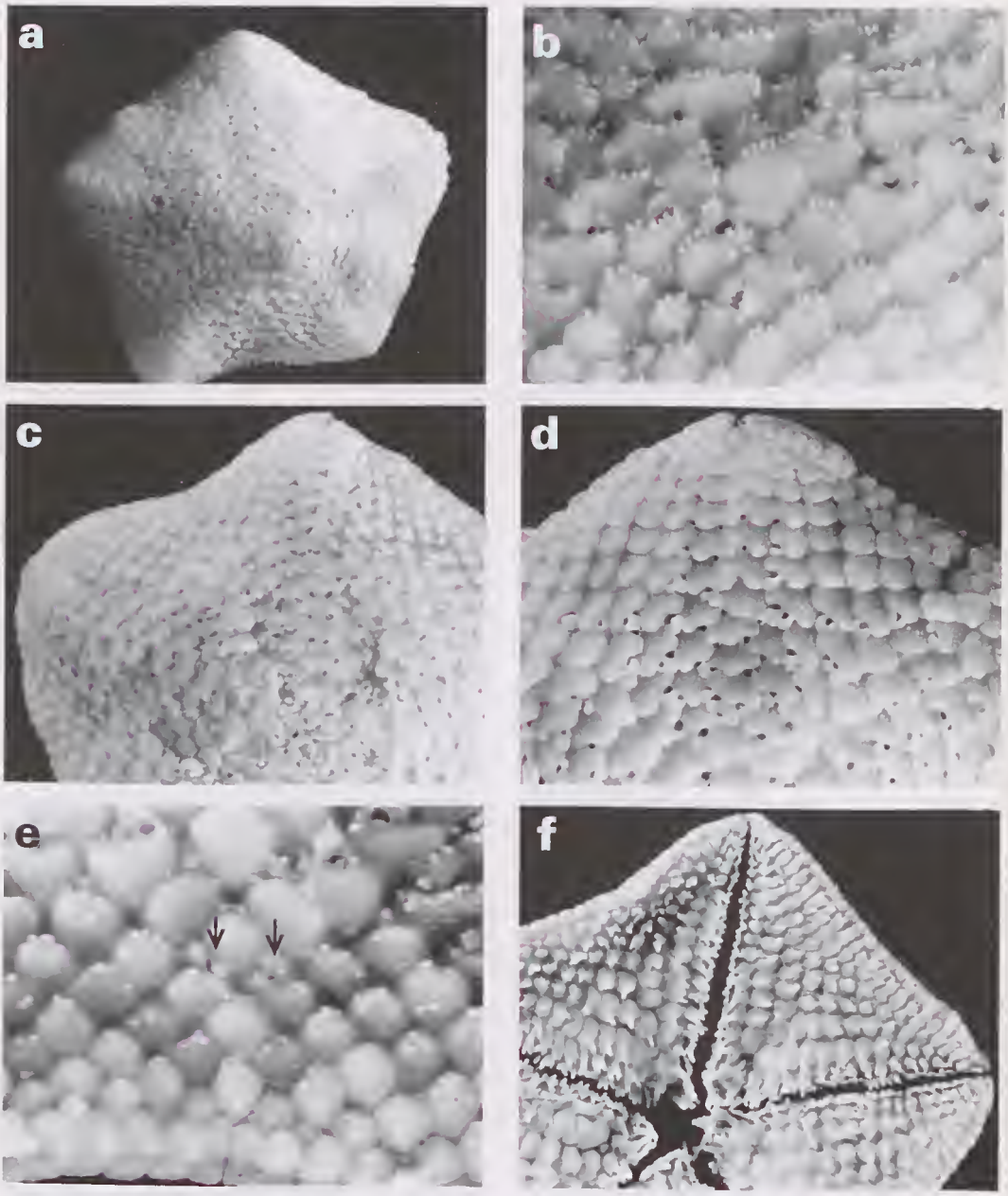

Figure 4. *Meridiastra modesta* (Verrill) comb. nov. a, abactinal view of lectotype (R = 7 mm) (YPM 24175); b, abactinal primary and secondary plates, and spinelets (0.15 mm long) (USNM 39110); c, abactinal rays and interradius (R = 10 mm) (USNM 39110); d, cleared abactinal ray and interradii (R = 7 mm) (paralectotype of *agustincasoi*); e, margin (lower) and distal interradial primary and secondary plates and spines, with spinous secondary plates proximal to two gonopores (arrows) (USNM 39110); f, actinal surface (USNM 39110).

mid-interradius, adjacent proximally to superomarginal plates; disc variably distinct, bordered by irregular pentagon comprising 5 proximal carinal and 5 smaller interradial plates; each radius with 4 longitudinal series of plates in mid-ray; radial plates with proximal edge slightly convex or straight or slightly concave, sometimes with slight median lobe; some radials indented proximally for 1 or commonly 2 or rarely 3 papulae; short proximal carinal series comprises typically 5 plates extending third to half ray length, distally 12–14 zig-zag radial plates; projecting interradial plates fan-shaped; abactinal plates granular, covered with conspicuous glassy convexities; plates with up to 12 short bluntly-pointed readily-detached glassy spinelets, 0.10–0.15 mm long, on proximal edge of plates in 1–2 irregular transverse rows, pointing apically; 4–6 vertical spinelets on crown of distal abactinal interradial plates; papulae commonly paired, small, longitudinal series along three quarters of ray laterally, few in proximal interradial areas; superomarginal plates not extending to margin, aligned with proximal edge of projecting inferomarginals except in mid-ray, each with up to 5 vertical spinelets concentrated distally on plate; secondary plates along proximal edge of superomarginals; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with marginal fringe of double oblique combs each up to 7 spinelets, up to 0.3 mm long; secondary plates adjacent to inferomarginals actinally; cleared actinal interradial plates in series curving obliquely or acutely from furrow to margin (from mid-ray); actinal interradial plates with predominantly 2 spines, variably 1–3; actinal adradial row of interradial plates lacking spines proximally, then irregular series of spines, predominantly 1, sometimes 2 mid-ray; adambulacral plates with predominantly 2 webbed subambulacral spines proximally, 1 distally; 4 furrow spines proximally, 3 mid-ray, 2 distally, webbed to tips; oral spines typically 5, subspatulate, not pointed; suboral spines 1, tall, tapered.

Live colour. Ivory, almost white (Caso, 1977).

Distribution. Pacific coasts of Panama and Mexico; rocky shallows.

Remarks. Caso (1977) distinguished *Asterina agustincasoi* from *Asterina miniata* Brandt, but did not distinguish the new species from *Asterina modesta*. Type material of *A. agustincasoi* and *A. modesta* was examined, and the species are synonymised. A lectotype and paralectotype series are established for *A. modesta*, and this species is reassigned to *Meridiastra*. H.L. Clark (1916, 1946) noted the similarity of *A. modesta* to *A. atyphoida*. Within the genus *M. modesta* is distinguished by: the short proximal carinal series of plates, some of which are doubly papulate; numerous proximal secondary plates; spinous secondary plates proximal to the abactinal gonopores; and predominantly paired actinal interradial spines. Having numerous proximal secondary plates makes the species unique within the new genus. The form of the abactinal spinelets, and disposition across the proximal edge of the plates, are characters quite similar to the type species *M. atyphoida*.

Meridiastra nigranota sp. nov.

Figures 5a–f

Asterina atyphoida.—Dartnall, 1970b: 19, fig. 1 [non *Asterina atyphoida* H.L. Clark, 1916].—Marsh and Pawson, 1993: 281 (part, Rottnest I. specimens) [non *Asterina atyphoida* H.L. Clark, 1916].

Material examined. Holotype. Australia, Victoria, Flinders, ocean platforms, shallow rocky sub-littoral, M. O'Loughlin, 13 Apr 1985, NMV F87414.

Paratypes. Type locality, 6 Jun 1969, TM H1058 (1); 17 Dec 1969, NMV F87232 (2+1 cleared); TM H493 (3); 6 Feb 1972, NMV F71938 (1); 10 Apr 1970, NMV F87413 (1); 7 Apr 1980, NMV F73002 (1); 13 Apr 1985, NMV F72030 (1+1 cleared); 12 Dec 1985, NMV F71930 (1); 17 Feb 1990, NMV F71931 (2); 11 Aug 1990, NMV F71941 (1); 5 Oct 1991, NMV F87234 (1); 22 Feb 1992, NMV F65914 (1); 12 Apr 1993, NMV F87174 (11); 9 May 1993, NMV F87226 (6); 12 Dec 1993, NMV F87231 (1).

Other material (selection for distribution and depth range). Victoria, Wilsons Promontory, 10 Mar 1984, NMV F71936 (1); Cape Paterson, 6 Mar 1982, NMV F71932 (2); Western Port, Crawfish Rock, 15 Feb 1969, NMV F73140 (1); Port Phillip Bay, Portarlington, 13 Mar 1977, NMV F73003 (1); Cape Nelson, 3 Mar 1984, NMV F71934 (1). Tasmania, NE between Ringarooma Bay and Waterhouse Point, Mar 1970, TM H1330 (1); King I., Currie, 10 Mar 1980, NMV F87162 (2); Tasman Peninsula, N of Thumbs Point, 6–10 m, 31 Jul 1991, SAM K1894 (5). South Australia, Port MacDonnell, 18 Mar 1976, AM J9909 (5); off Cape Northumberland, 30 m, 14 Jul 1974, SAM K1892 (1). Western Australia, Rottnest I., Little Armstrong Bay, 0 m, 9 Jan 1991, WAM Z6856 (1); Ricey Beach, 0–1 m, 14 Jan 1991, WAM Z6857 (1).

Description. Small, up to R = 13 mm; form pentagonal, interradial edges straight, sometimes near-pentagonal with interradial margins incurved, typically R/r = 1.3; rays 5, ends

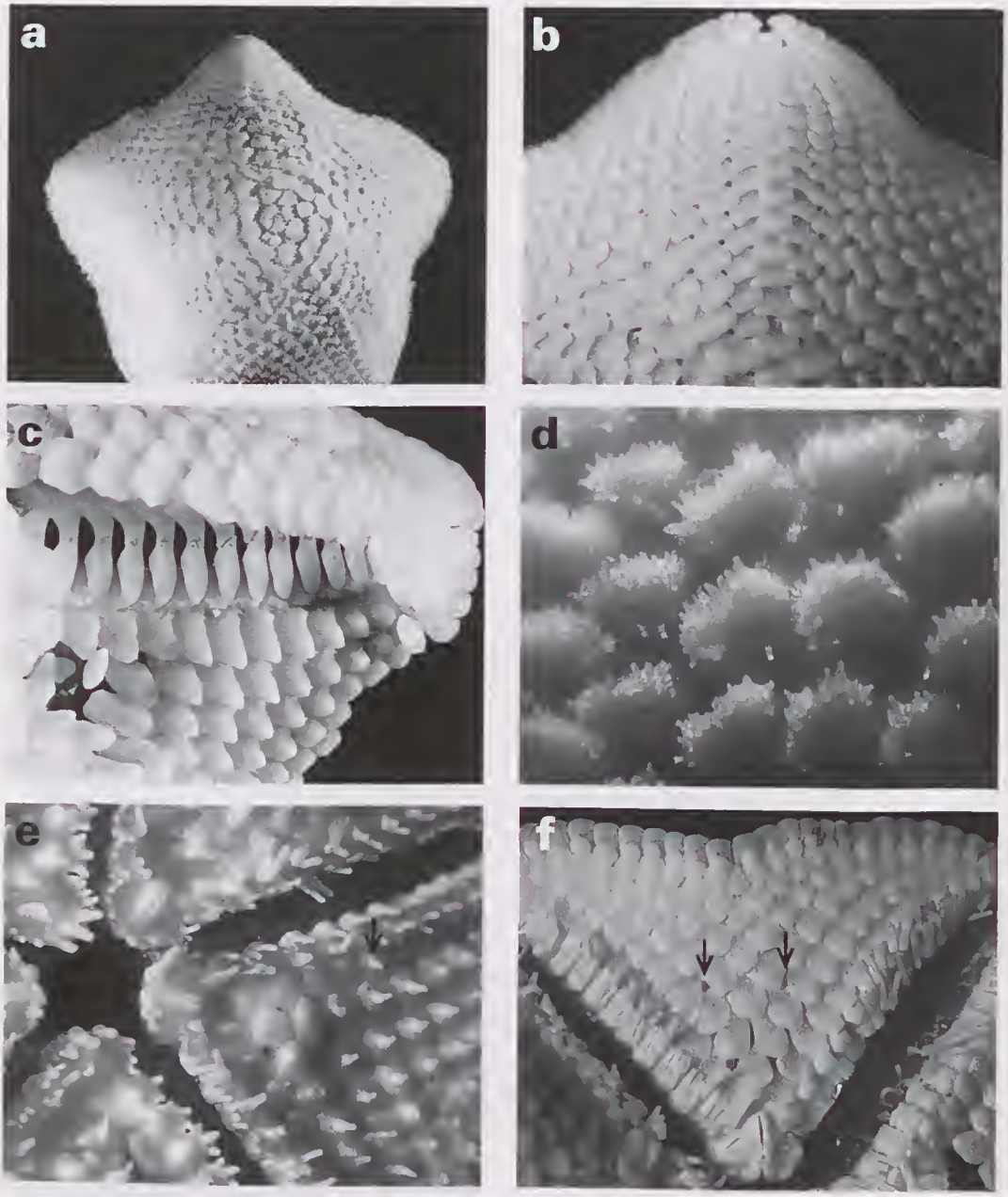

Figure 5. *Meridiastra nigranota* sp. nov. a, abactinal view of holotype (R = 7 mm) (NMV F87414); b, cleared abactinal ray and interradii (paratype NMV F87232; R = 8 mm); c, abactinal view of disseeted and cleared interradius, showing ambulacral plates and absence of superambulacral plates (paratype NMV F87232); d, abactinal plates and spinelets (0.15 mm long) (holotype); e, proximal actinal view, with single spine (arrow) on adradial plates (NMV F87162); f, cleared actinal view, with gonopores (arrows) (paratype NMV F87232).

rounded; body flat orally, thin, slightly domed or low pyramidal aborally, acute angle at margin; single triangular madreporite; not fissiparous; pedicellariae absent; paired interradial gonopores actinal.

Abactinal plates closely imbricate, in regular series; papular spaces small; papulate areas less extensive than non-papulate areas; secondary plates rare, apical and marginal only, never separating carinal plates; disc variably distinct, bordered by irregular pentagon comprising 5 proximal carinal and 5 interradial plates; each radius with 5 longitudinal series of plates in mid-ray; distinct proximal carinal series comprises up to 12 (rarely 13) plates extending three quarters of ray length, distally 2–12 zig-zag radial plates; carinals with proximal edge slightly convex or straight or concave, some with slight median lobe; some radials indented proximally for 1 or rarely 2 papulae; projecting interradial plates fan-shaped; abactinal plates granular, covered with conspicuous glassy convexities; plates with frequently more than 20 fine pointed rugose terminally-spinous frequently-webbed readily-detached glassy spinelets, up to 0.2 mm long, clustered across proximal edge in irregular single and double transverse series, frequently also scattered over plate, on projecting crown of distal interradial plates; papulae small, mostly single, on disc and proximal two-thirds of radial areas, in proximal third only of carinal series, 4, longitudinal series in mid-ray, few on proximal interradial areas; superomarginals not extending to margin, aligned with proximal edge of projecting inferomarginals, each with up to 6 vertical spinelets; some secondary plates along proximal edge of superomarginal series; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with marginal fringe of 5–6 distal fine webbed spinelets, typically 0.25 mm long, proximal transverse row of shorter spinelets (typically 4); some secondary plates at actinal edge of inferomarginal series; cleared actinal plates in regular series, curving obliquely or acutely from furrow to margin or perpendicular to furrow; actinal interradial plates with 1 spine, frequently 2 in mid-interradius, 1–3 very small spines distally; actinal adradial row of interradial plates with none to very few to incomplete series of frequently reduced spines; adambulacral plates with 1–2 tall subambulacral spines proximally, frequently 2 from mid-ray distally; 3 webbed furrow spines, 2–1 distally; oral spines 4-6 (commonly 5); suboral spines rarely present, frequently reduced if present.

Live colour. Aboral colour white to faun to pale grey, with irregular black to dark reddish-black to dark greenish-black spotting, some brownish-red to red spots distally; disc dark greenish-black; madreporite white; faint red flecking around ends of rays; white orally.

Distribution. Southern Australia, Wilsons Promontory, Victoria, to Rottnest I., Western Australia; Tasmania south to Tasman Peninsula; 0–30 m.

Etymology. From Latin *niger* (black) and *nota* (spot), referring to the fine black aboral spotting on live animals.

Remarks. Within *Meridiastra* the combination of diagnostic characters which distinguish *M. nigranota* are the pentagonal form; long regular proximal carinal series of plates extending more than half the ray length; absence of proximal secondary plates except rarely within the disc; absence or irregular presence of spines on the adradial actinal plates; predominantly paired subambulacral spines; frequent absence of suboral spines; and actinal gonopores. Within the new genus *M. nigranota* is most closely related to *M. atyphoida*, from which it is distinguished by live colour and actinal gonopores.

Meridiastra rapa sp. nov.

Figures 6a–f

Asterina sp.—Marsh, 1974: 92–93.

Material examined (all dry). Holotype. South Pacific, Austral Ridge, Rapa I., Haurei Bay, off Point Turagainuu, under basalt boulders, 1–2 m, D.M. Devaney, Feb 1971, BPBM W3507.

Paratypes. Type series, BPBM W3033 (3); WAM Z6875 (2).

Other material. Type locality, 27 Nov 1963, USNM E53099 (1).

Description of material. Small, up to R = 5.5 mm (type series; R = 7 mm for flattened USNM E53099); form pentagonal, interradial edges straight, or near-pentagonal with interradial margins incurved, typically R/r = 1.3; rays 5, ends rounded; body flat orally, thin, slightly domed aborally, acute angle at margin; single triangular madreporite; not fissiparous; pedicellariae absent; paired interradial gonopores abactinal.

Abactinal plates closely imbricate, in regular series except proximally; papular spaces small; papulate areas slightly less extensive than

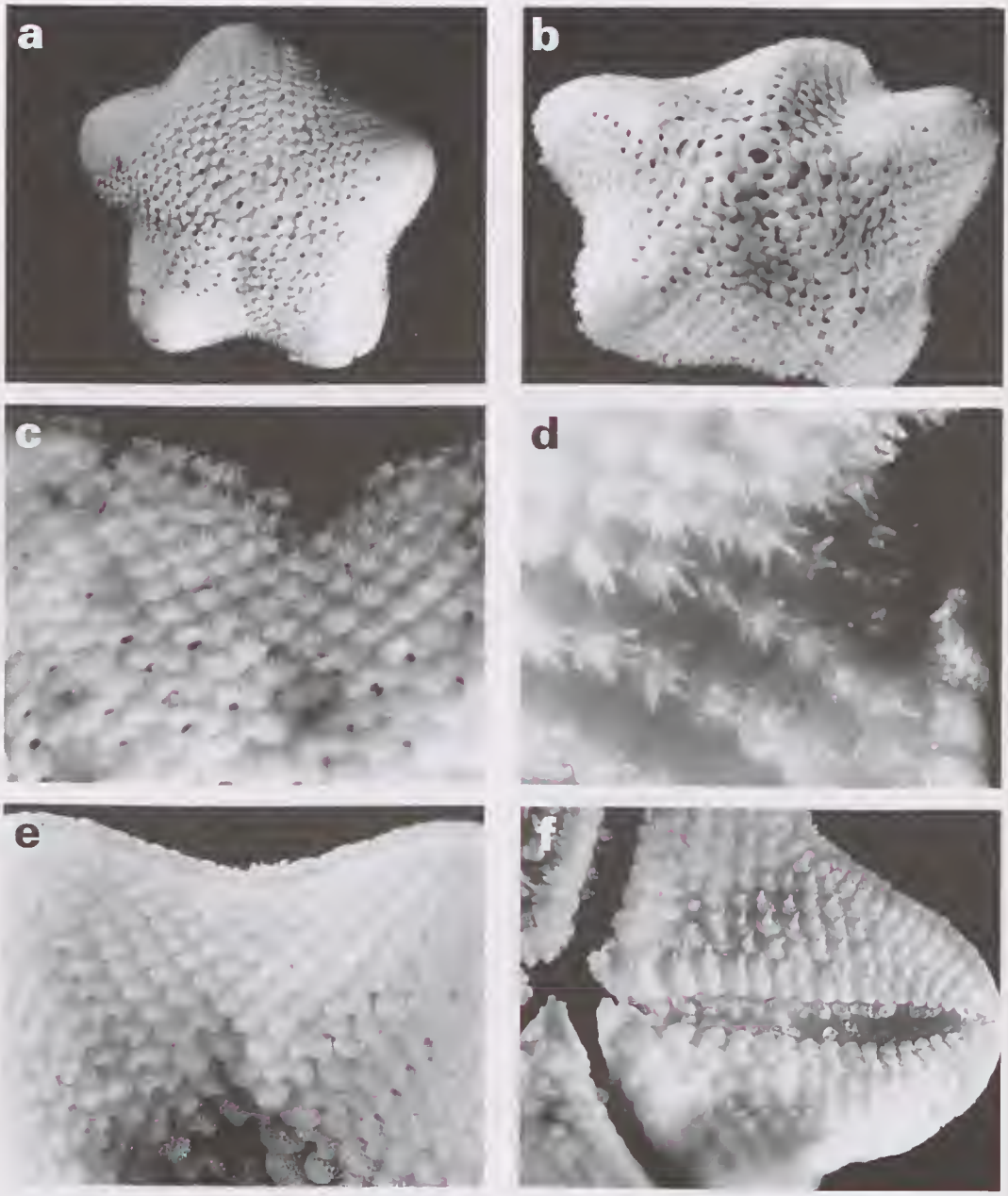

Figure 6. *Meridiastra rapa* sp. nov. a, abactinal view of holotype (R = 5.5 mm) (BPBM W3507); b, abactinal view of cleared paratype (R = 5 mm) (BPBM W3033); c, abactinal interradius of holotype showing spinelets (0.1 mm long); d, distal abactinal interradial spinelets (0.1 mm long) (paratype WAM Z6875); e, abactinal rays and interradius (paratype WAM Z6875); f, actinal view (paratype WAM Z6875).

non-papulate areas; secondary plates absent abactinally; lacking distinct disc; apical plates large, irregular; lacking regular carinal series of plates, sometimes about 4 irregular proximal carinal plates; ray defined by 2 lateral longitudinal series of plates singly notched for proximal two-thirds of ray; mid-ray longitudinally comprises 2 series of alternating plates for length of ray, least regular proximally, sparsely papulate with proximal plate edge slightly notched or concave for proximal half of ray; each ray with 4 longitudinal series of plates in mid-ray; projecting interradial plates fan-shaped; abactinal plates granular, covered with fine glassy convexities; plates with up to 14 fine pointed readily-detached glassy spinelets, typically 0.15 mm long, vertical across free edge of proximal plates in irregular double series, sometimes webbed, on crown of distal plates; papulae single, papular spaces small, papulae principally radial, distinct single series along proximal two-thirds of ray laterally, 3 irregular longitudinal series of papulae in mid-ray; some on proximal interradial areas; superomarginals not extending to margin, aligned with proximal edge of projecting inferomarginals, each with typically 2–3 vertical spinelets; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with some internal vertical contiguous projections.

Projecting inferomarginal plates form margin; marginal fringe of oblique combs of spinelets, sometimes webbed, sometimes double series, up to 8, typically 0.2 mm long; few secondary plates adjacent to inferomarginals; actinal plates (cleared) in series curving obliquely (obtusely) from furrow to margin; actinal interradial plates with 1–2 spines, predominantly 1; actinal adradial row of interradial plates all with 1 spine; adambulacral plates with 1–2 tall subambulacral spines, predominantly 2; predominantly 3 webbed furrow spines, 2 distally; oral spines 5; suboral spines 1–2.

Etymology. Named after the type locality, Rapa I., noun in apposition.

Distribution. Rapa I.; 0–2 m.

Remarks. Within *Meridiastra* the combination of diagnostic characters which distinguish *M. rapa* are the close to pentagonal form; very small size (up to R = 5.5 mm); very irregular short proximal carinal series of plates; irregular proximal plates and absence of a distinct disc. *M. rapa* and *M. fissura* both have irregular proximal abactinal plates, and lack a distinct disc.

Asterinides Verrill

Figures 7a–e

Asterinides Verrill, 1913: 479.—Verrill, 1915: 58.—Fisher, 1919: 410.—A.M. Clark, 1983: 364.—Clark and Downey, 1992: 178.—A.M. Clark, 1993: 214.—Rowe (in Rowe and Gates), 1995: 33.—Rowe (in Campbell and Rowe), 1997: 131.

Type species. Asteriscus folium Lütken, 1860.

Diagnosis. Small, up to R = 15 mm; form near-pentagonal, interradial margins slightly incurved, R/r = 1.3; rays 5, ends rounded; body flat orally, low dome aborally, acute angle at margin; madreporite plate with pores centrally only; pedicellariae absent; abactinal gonopores.

Abactinal plates imbricate, in regular series; papular spaces prominent; papulate areas more extensive than non-papulate areas; disc clearly delineated, 4 (one occupied by madreporite) ad-disc interradial papular spaces with 2 papulae separated by 1–2 secondary plates; proximal secondary plates rare; proximal radial and interradial plates with distinct papular notch creating near-crescentic appearance; some proximal and distal interradial plates with small dome on crest; abactinal plates granular, covered with conspicuous glassy convexities; abactinal proximal plates with central tuft of up to 20 slender readily-detached glassy spinelets, up to 0.25 mm long, distal and midinterradial superomarginal plates with vertical clusters of near-paxilliform radiating spinelets; superomarginal plates not extending to margin, not always aligned with inferomarginals; distal interradial and superomarginal plates small, irregular in size and form; papulae numerous, large, single, in distinct papular notch; lacking superambulacral internal plates; distal actinal and abactinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with clusters of crowded radiating spinelets, up to 0.25 mm long; cleared actinal interradial plates in regular series, curving acutely from furrow to margin; actinal interradial plates with 3–4 spines midradially; adambulacral plates with 3-4 webbed subambulacral spines; 3-5 webbed furrow spines; 1–6 suboral spines.

Remarks. Verrill (1913) distinguished *Asterinides* from *Asterina* by the former's lack of pedicellariae. Verrill (1913) assigned *A. cepheus* (Müller and Troschel) from northern Australia, and *A. modesta* (Verrill) from the eastern Pacific, to *Asterinides*. Fisher (1919) did not regard the presence or absence of pedicellariae as a reliable diagnostic character, and based on the similarity of the

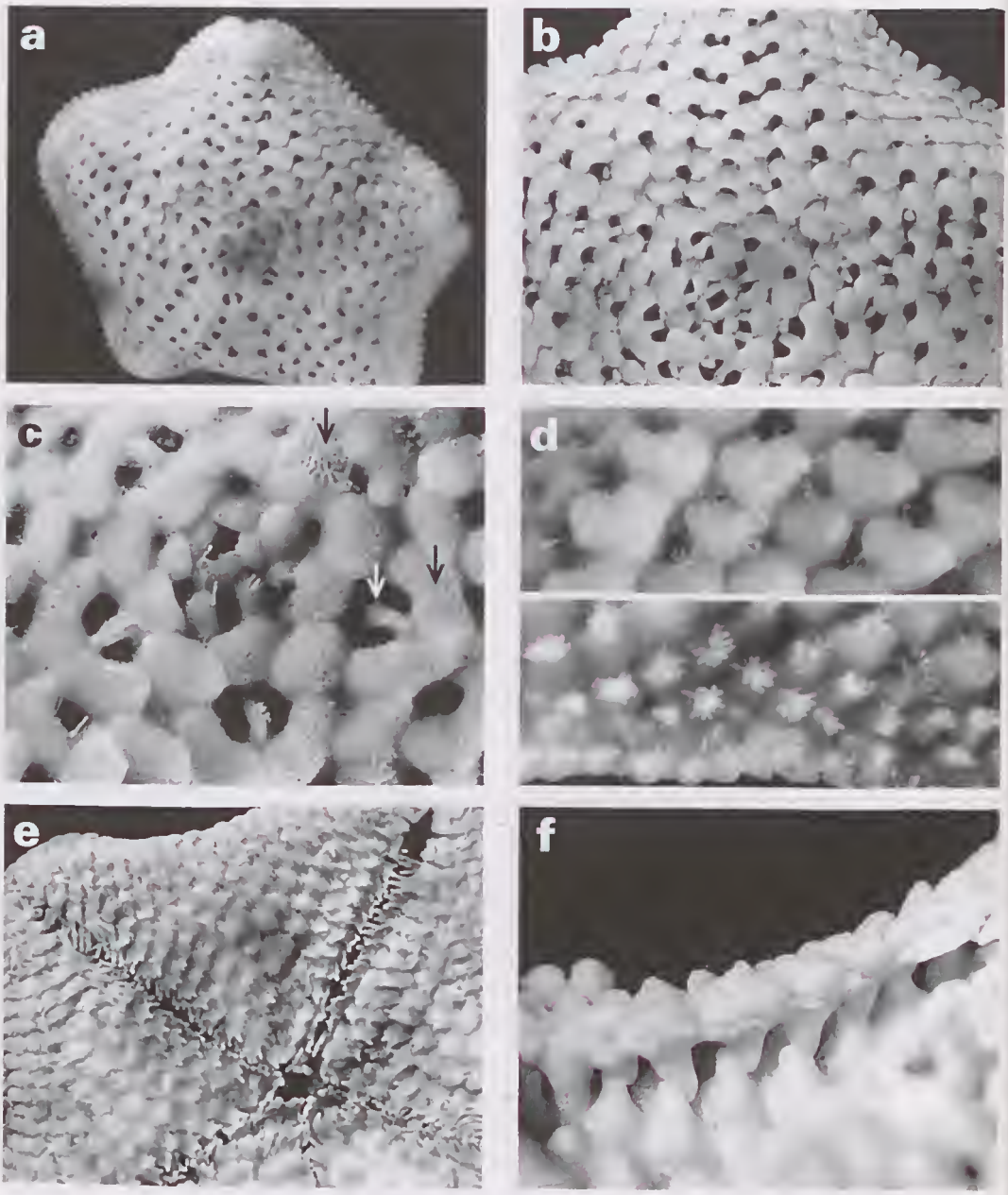

Figure 7. a–e, *Asterinides folium* (Lütken). a, uncleared abactinal view (R = 7 mm) (USNM 38811); b, cleared abactinal proximal plates, showing disc (USNM 38811); c, uncleared disc with madreporite (top, arrow), ad-disc papular spaces with longitudinal secondary plates (one at white arrow) and subtending pairs of concave plates (one at black arrow) (USNM 38811); d (upper), abactinal proximal interradial plates with tufts of spinelets (up to 0.25 mm long) (USNM 38811); d (lower), abactinal distal interradial plates with near-paxilliform clusters of spinelets (USNM 38236); e, actinal view (USNM 38811); f, *Asterina gibbosa* (Pennant), dissected and cleared distal interradius with contiguous internal projections of abactinal and actinal plates (NMV F87241).

abactinal skeleton and spines synonymised *Asterinides* with *Asterina*. A.M. Clark (1983) and Clark and Downey (1992) considered that *Asterinides* might be revived, based on the delicate abactinal spinelets and relatively low and near-pentagonal body form. Rowe and Berents (pers. com.) and Rowe (in Rowe and Gates, 1995 and in a note in Campbell and Rowe, 1997) supported the recognition of *Asterinides* as a valid genus. *A. modesta* is reassigned above to *Meridiastra* gen. nov. Specimens of *A. cepheus* from Queensland (AM J23331) and New Guinea (AM J22934) were examined. Although the arms were distinct and secondary plates absent, having a combination of slender glassy abactinal spinelets, numerous actinal spines on each plate, abactinal plates notched for single papulae, small papular spaces, papulate more extensive than non-papulate areas, irregular carinal series, abactinal gonopores, and no pedicellariae supports a retention of this species in *Asterinides*.

Based on the two type species *Asterina gibbosa* (Pennant) and *Asterinides folium* (Lütken), the combination of characters distinguishing *Asterina* Nardo and *Asterinides* Verrill are listed in Table 2. Based on the type species *Asterinides folium* (Lütken), the combination of characters distinguishing *Asterinides* Verrill and *Meridiastra* gen. nov. are listed in Table 3.

Asterinides folium (Lütken, 1860)

Figures 7a–e

Synonymy. See Clark and Downey (1992: 182–183).

Material examined. Holotype. Virgin Is, St Thomas, Consul Krebs (ZMUC).

Other material. Atlantic Ocean, Gulf of Mexico, Florida, Florida Keys, off Key West, Sand Key Reef, J.B. Henderson, no date, USNM 38811 (3); Bermuda, Hungry Bay, Sep 1901, USNM 38236 (4).

Description of material. Small, up to R = 15 mm; form near-pentagonal to arms slightly petaloid, typically R/r = 1.4; rays 5, ends rounded; body flat orally, low dome aborally, acute angle at margin; single madreporite, not triangular, pores centrally only on plate; not fissiparous; pedicellariae absent; paired interradial gonopores abactinal.

Abactinal plates imbricate, in regular series; papular spaces conspicuous; papulate areas more extensive than non-papulate areas; secondary plates sometimes in papular spaces, some along superomarginal series, some next to inferomarginals actinally; disc inconspicuous but distinctive, bordered by pentagon comprising 5 proximal carinal and 5 interradial plates, 5 ad-disc interradial papular spaces each with 2 lateral papulae separated by 1–2 secondary plates or madreporite plate; carinal plates irregularly present proximally, series up to 7 extending one third of ray distally, midradials zig-zag longitudinally for distal two-thirds of ray; proximal radial and interradial plates with papular notch creating near-crescentic appearance, up to 2 carinals doubly notched; some proximal and distal interradial plates with small dome on crown; distal interradials and superomarginals small, irregular in size and arrangement, superomarginals not always aligned with inferomarginals; abactinal plates granular, covered with conspicuous glassy convexities; proximal plates with central tuft of up to 20 very slender, pointed, very readily-displaced, glassy spinelets, up to 0.25 mm long, orientated apically over papular space, some spinelet clusters near-paxilliform; distal interradial plates and midinterradial superomarginal plates with vertical clusters of near-paxilliform radiating spinelets; papulae large, single except for 1–2 carinals, distinct papular notches, some papular spaces with 1–3 secondary plates, papulae extending four fifths of ray distally, up to three quarters of interradius distally; longitudinal papular series up to 8-wide in mid-ray; lacking internal supercrambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, each with clusters of crowded laterally-radiating spinelets up to 0.25 mm long; cleared actinal interradial plates in regular series, curving acutely from furrow to margin from mid-ray distally; actinal interradial plates with 2–5 slender webbed spines, predominantly 3–4 in midinterradius; adradial row of actinal interradial plates with 3–4 webbed spines; adambulacral plates with 3–4 webbed subambulacral spines, 3–5 webbed furrow spines; oral plates with 5–6 spines; 1–6 suboral spines, some webbed.

Distribution. See Clark and Downey (1992: 183).

Remarks. Verrill (1915) noted the absence of "gyri" (wavy perforations) around the base of the madreporite plate. The abactinal plates of the Bermuda specimens (USNM 38236) frequently had domes on the crests, which were not evident on the holotype or in the Florida material (USNM 38811). Subsequent to the synonymy of Clark and Downey (1992), Rowe (in Rowe and Gates, 1995 and in a note in Campbell and Rowe, 1997) discussed the referral of *A. folium* to *Asterinides*, as noted above.

Table 1. Characters distinguishing *Asterina gibbosa* (Pennant) and *Meridiastra* gen. nov.

Asterina gibbosa (Pennant)	*Meridiastra* gen. nov.
larger size; R up to 35 mm	small size; R up to 13 mm
short-rayed stellate form; arms distinct	pentagonal or near-pentagonal form
crescentic, openly imbricating, abactinal plates	fan-shaped, closely imbricating, abactinal plates
oval or lobed madreporite	triangular madreporite
clearly delineated disc	disc poorly delineated or not distinct
ad-disc triangular interradial papular spaces with more than two secondary plates	lacking ad-disc triangular interradial papular spaces
papulate areas greater than non-papulate	non-papulate areas greater than papulate
large papular spaces with numbers of papulae	small papular spaces with single papulae
pedicellariae present	pedicellariae absent
blunt opaque firmly-attached abactinal spinelets	fine glassy readily-detached spinelets
abactinal spinelets on crown of plates	abactinal spinelets on free margin of plates

Table 2. Characters distinguishing *Asterina* Nardo and *Asterinides* Verrill.

Asterina gibbosa (Pennant)	*Asterinides folium* (Lütken)
larger size; R up to 35 mm	small size; R up to 15 mm
short-rayed stellate form; arms distinct	pentagonal or near-pentagonal form
numerous secondary plates abactinally	rare secondary plates abactinally
whole madreporite plate with pores	madreporite plate with pores centrally only
ad-disc triangular interradial papular spaces with more than 2 secondary plates	ad-disc triangular interradial papular spaces divided by 1–2 secondary plates
papular spaces large, with numbers of papulae	papular spaces smaller, with single papulae
pedicellariae present	pedicellariae absent
blunt opaque firmly-attached abactinal spinelets	fine glassy readily-detached spinelets
abactinal spinelets over crown of plates	abactinal spinelets in tufts on plates
gonopores actinal	gonopores abactinal

Table 3. Characters distinguishing *Asterinides* Verrill and *Meridiastra* gen. nov.

Asterinides folium (Lütken)	*Meridiastra* gen. nov.
abactinal plates prominently notched, near-crescentic	abactinal plates fan-shaped, not near-crescentic
madreporite plate with pores centrally only	whole madreporite plate with pores
ad-disc triangular interradial papular spaces divided by 1–2 secondary plates	lacking ad-disc triangular interradial papular spaces
papular spaces conspicuous	papular spaces inconspicuous
papulate areas greater than non-papulate	non-papulate areas greater than papulate
abactinal spinelets in tufts on plates	abactinal spinelets across free margin
actinal interradial plates with 3-4 spinelets in mid-ray	actinal interradial plates with 1–2 spinelets in mid-ray

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REPORT ON SELECTED SPECIES OF BANZARE AND ANARE HOLOTHUROIDEA, WITH REVIEWS OF *MESERES* LUDWIG AND *HETEROCUCUMIS* PANNING (ECHINODERMATA)

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Abstract

O'Loughlin, P.M., 2002. Report on selected species of BANZARE and ANARE Holothuroidea, with reviews of *Meseres* Ludwig and *Heterocucumis* Panning (Echinodermata). *Memoirs of Museum Victoria* 59(2): 297–325.

Selected Holothuroidea species collected by The British, Australian and New Zealand Antarctic Research Expedition (BANZARE) 1929–1931 from Kerguelen I. and eastern Antarctica, are listed. Relevant species of Holothuroidea also collected from the Kerguelen region (Heard I.) and eastern Antarctica by the Australian National Antarctic Research Expeditions (ANARE) 1985–1997 are reported and discussed. The genera *Meseres* Ludwig and *Heterocucumis* Panning are reviewed. The genus *Ekmocucumis* Heding and subgenus *Ekmocucumis* Panning are junior synonyms of *Staurocucumis* Ekman. A new Antarctic genus of the Cucumariidae, *Psolicrux*, and a new species of Synallactidae, *Meseres spiculiferus*, are described. Systematic and distribution notes are provided for *Chiridota pisanii* Ludwig, *Taeniogyrus contortus* (Ludwig), *Bothyplotes bongraini* Vaney, *B. gourdoni* (Vaney), *Meseres globigerinae* (Hérouard), *M. hyalegerus* Sluiter, *M. involutus* Sluiter, *M. macdonaldi* Ludwig, *M. occultatus* (Marenzeller), *M. peripatus* Sluiter, *M. propinquus* (Fisher), *M. torvus* (Théel), *M. trachus* (Sluiter), *M. villosus* (Théel), *Mesothuria bifurcata* Hérouard, *Pseudostichopus atlanticus* Perrier, *Heterocucumis godeffroyi* (Semper), *H. steineni* (Ludwig), *Psolicrux coatsi* (Vaney), *Staurocucumis liouvillei* (Vaney), *Trachythyone lechleri* (Lampert), *Paracucumis turricata* (Vaney), *Amperima robusta* (Théel), *Rhipidothuria racovitzai* Hérouard and *Laetmogone wyvillethomsoni* Théel. *Pseudostichopus globigerinae* Hérouard is removed from the synonymy of *Pseudostichopus villosus* Théel, and assigned to *Meseres*. *Pseudostichopus propinquus* Fisher is removed from the synonymy of *Pseudostichopus pustulosus* Sluiter, and assigned to *Meseres*. A list of species with original and current name combinations, and a summary of new distributions, are tabulated.

Introduction

The British, Australian and New Zealand Antarctic Research Expedition (BANZARE), under the command of Sir Douglas Mawson, comprised two voyages by the *Discovery*. The first voyage left Cape Town in October 1929 and worked off southern Africa, Crozet, Kerguelen, Heard, eastern Antarctica (40° to 80°E), and south-western Australia. The second voyage left Hobart in November 1930 and worked off southern Tasmania, Macquarie, Scott, eastern Antarctica (60° to 180°E), and western Tasmania. Station data were detailed by Johnston (1937). In the *Reports* following the Expedition, John (1939) reported on the Crinoidea, Mortensen (1950) on the Echinoidea, A.M. Clark (1962) on the Asteroidea, and Madsen (1967) on the Ophiuroidea. The remaining Echinodermata from BANZARE, the Holothuroidea, are reported in part here. Material examined comprised 20 lots of 12 species, including all of the Aspidochirotida and Elasipodida with some Apodida and Dendrochirotida. BANZARE Reports are no longer published by the University of Adelaide. This collection is lodged in the South Australian Museum.

Recent holothurian collections, taken by the Australian National Antarctic Research Expeditions (ANARE) 1985–1997 from Heard I. and eastern Antarctica, are held in part by Museum Victoria. Some ANARE species are referred to in this report to augment the data provided by the BANZARE material, for the purposes of refining the on-going systematic account of the Antarctic and Kerguelen region holothurians and clarifying which species have a distribution including the southern coasts of South America, Antarctic

coast, and Kerguelen region. Determination of some BANZARE lots necessitated a review of the genera *Meseres* Ludwig, 1894 and *Heterocucumis* Panning, 1949. A new Antarctic genus of the Cucumariidae, *Psolicrux*, and new species of Synallactidae, *Meseres spiculiferus*, are described. *Pseudostichopus globigerinae* Hérouard, 1923 is removed from the synonymy of *Psendostichopus villosus* Théel, 1886, and referred to *Meseres*. *Pseudostichopus propinquus* Fisher, 1907 is removed from the synonymy of *Pseudostichopus pustulosus* Sluiter, 1901, and referred to *Meseres*. The genus *Ekmocucumis* Heding, 1942 and subgenus *Ekmoecucumis* Panning, 1949 are synonymised with *Staurocucumis* Ekman, 1927, and *Heterocucumis* Panning, 1949 is raised to generic status. All species considered in this report, with new synonymies and new combinations, are listed in Table 1; BANZARE species are listed in Table 2; and new extensions of distribution are listed in Table 4.

Some of the material examined provided evidence of possible regional variations for some species, but in the absence of growth series and adequate numbers of specimens the evidence is considered to be insufficient for the establishment of additional species. Variations, principally in size, are noted.

Abbreviations for institutions are: AM, Australian Museum, Sydney; BMNH, The Natural History Museum, London; IRSNB, Institut Royal des Sciences naturelles de Belgique, Brussels; MNHN, Muséum National d'Histoire Naturelle, Paris; NMV, Museum Victoria, Melbourne, Australia; SAM, South Australian Museum, Adelaide; USNM, US Museum of Natural History, Smithsonian Institution, Washington; ZIM, Zoological Institute and Museum, Hamburg; ZMA, Zoölogisch Museum, Amsterdam; ZMUC, Zoological Museum, University of Copenhagen.

The Magellanic region refers to southern Chile, southern Argentina, and the Falkland Is. The Kerguelen region refers to depths of less than 600 m around Kerguelen, Heard, and the McDonald Is. Bathyal refers to depths of 200–2600 m; abyssal to 2600-6000 m (following Hansen, 1975).

Order **Apodida** Brandt

Chiridotidae Östergren

Chiridota pisanii Ludwig

Chirodota pisanii Ludwig, 1886: 29–30, pl. 2 fig. 14.
Chirodota purpurea.—Théel, 1886a: 15, 35, pl. 2 fig. 1 [non *Trochodota purpurea* (Lesson, 1830)].
Chiridota pisanii.—Ludwig, 1892: 359.

Complete synonymy. See Pawson (1964: 464).

Material examined. Heard I., 52°41′–53°13′S, 72°56′–73°41′E, 120–228 m [ANARE, NMV F84977–84979 (3 specimens)]. Argentina, Tierra del Fuego, 54°00′S, 67°24′W, 0 m, 1999 [NMV F86016 (2)].

Type locality. Calbuco, Chile.

Distribution. Magellanic region, from Seno Reloncavi in Chile to 43°S on the coast of Argentina, Falkland Is, 0–102 m (summary by Pawson, 1969). Kerguelen region, Heard I., 120–228 m (this paper).

Remarks. The specimens of *C. pisanii* from Heard I. and Tierra del Fuego were identical in tentacle number (12), tentacle digits (5–7 pairs, distalmost pair largest), and ossicle complement [wheels, up to 0.10 mm diameter, in papillae clusters; short unbranched rods (miliary granules), 0.04–0.05 mm long, in longitudinal muscles; curved tentacles rods, typically 0.08-0.10 mm long; lacking sigmoid hooks]. Théel (1886a) gave a similar description of specimens of *C. pisanii* from the Falkland Is (as *Chirodota purpurea*), but reported wheel diameters up to 0.16 mm. Pawson (1964) reported bracket-shaped tentacle rods with an average length of 0.05 mm in material from southern Chile. ANARE specimens of *C. pisanii* taken off Heard I. are the first record for the Kerguelen region, where the species is reported at a greater depth. *C. pisanii* has not been reported for Antarctica.

Taeniogyrus contortus (Ludwig)

Chirodota contorta Ludwig, 1875: 80-81, pl. 6 figs 6a–c.
Taeniogyrus contortus.—H.L. Clark, 1907: 121–123, pl. 7 figs 8–13.
Taeniogyrus cf. *contortus*.—O'Loughlin et al., 1994: 553, 554.

Complete synonymy. See Pawson (1964: 466-467).

Material examined. Syntypes (?). Argentina, Santa Cruz, east of Grande Bay, 51°34′S, 68°00′W, 91 m, 1888 [*Albatross* Stn 2771, USNM 19826 (3)].

Other material. Chile, Inutil Bay, 53°35′S, 69°45′W, 37-46 m, 1969 [USNM E33679 (13)]; 53°34′S, 69°59′W, 82-91 m, 1970 [USNM E33715 (9)]. Eastern Antarctica, off Wilkes Land, 66°18′S, 110°32′E, 101 m, 1961 [USNM E33725 (25)]; MacRobertson Shelf, 66°55′–67°16′S, 62°32′–68°59′E, 109–216 m [ANARE, NMV F68691 (20), F69099 (2), F69100 (2)]. Kerguelen I., Royal Sound, 49°28′S, 70°04′E, 4–5 m, 1929 [BANZARE Stn 12, SAM K1839 (1)]; 49°30′S, 69°48′E, 2–20 m, 1930 [BANZARE Stn 49, SAM K1840 (1)].

Table 1. Index of species in paper, including new synonymies and new combinations.

Original combination	Current combination or senior synonym	Family
abyssorum, Cucumaria, Théel, 1886	*Staurocucumis abyssorum* (Théel, 1886)	Cucumariidae
acaudum, Molpadiodemas, Heding, 1935	*Pseudostichopus atlanticus* Perrier, 1898	Synallactidae
alatus, Pseudostichopus (Pseudostichopus), Imaoka, 1990	*Pseudostichopus alatus* Imaoka, 1990	Synallactidae
aleutianus, Pseudostichopus, Ohshima, 1915	*Meseres peripatus* Sluiter, 1901	Synallactidae
antarctica, Cucumaria, Vaney, 1906	*Heterocucumis steineni* (Ludwig, 1898)	Cucumariidae
antarctica, Paracucumis, Mortensen, 1925	*Paracucumis turricata* (Vaney, 1906)	Paracucumidae
arenosus, Pseudostichopus, Ohshima, 1915	*Pseudostichopus arenosus* Ohshima, 1915	Synallactidae
atlanticus, Pseudostichopus, Perrier, 1898	*Pseudostichopus atlanticus* Perrier, 1898	Synallactidae
belyaevi, Amperima, Gebruk, 1988	*Amperima belyaevi* Gebruk, 1988	Elpidiidae
bifurcata, Mesothuria, Hérouard, 1901	*Mesothuria bifurcata* Hérouard, 1901	Synallactidae
bistriatum, Psolidium, Ludwig and Heding, 1935	*Psolicrux coatsi* (Vaney, 1908)	Cucumariidae
bongraini, Bathyplotes, Vaney, 1914	*Bathyplotes bongraini* Vaney, 1914	Synallactidae
coatsi, Psolidium (Cucumaria), Vaney, 1908	*Psolicrux coatsi* (Vaney, 1908)	Cucumariidae
conspicua, Cucumaria, Vaney, 1908	*Psolicrux coatsi* (Vaney, 1908)	Cucumariidae
contorta, Chirodota, Ludwig, 1875	*Taeniogyrus contortus* (Ludwig, 1875)	Chiridotidae
denticulata, Cucumaria, Ekman, 1927	*Heterocucumis denticulata* (Ekman, 1927)	Cucumariidae
dilatorbis, Pseudostichopus (Pseudostichopus), Imaoka, 1978	*Pseudostichopus dilatorbis* Imaoka, 1978	Synallactidae
fuscivinculum, Bathyplotes, Gutt, 1990	*Bathyplotes bongraini* Vaney, 1914	Synallactidae
globigerinae, Pseudostichopus, Hérouard, 1923	*Meseres globigerinae* (Hérouard, 1923)	Synallactidae
godeffroyi, Cucumaria, Semper, 1868	*Heterocucumis godeffroyi* (Semper, 1868)	Cucumariidae
godfroyi, Cucumaria, Vaney, 1914	*Heterocucumis steineni* (Ludwig, 1898)	Cucumariidae
gourdoni, Synallactes (?), Vaney, 1914	*Bathyplotes gourdoni* (Vaney, 1914)	Synallactidae
grandis, Cucumaria, Vaney, 1906	*Staurocucumis grandis* (Vaney, 1906)	Cucumariidae
hassleri, Thyone, Théel, 1886	*Trachythyone lechleri* (Lampert, 1885)	Cucumariidae
hyalegerus, Meseres, Sluiter, 1901	*Meseres hyalegerus* Sluiter, 1901	Synallactidae
ingolfi, Plicastichopus, Heding, 1942	*Meseres peripatus* Sluiter, 1901	Synallactidae
involutus, Meseres, Sluiter, 1901	*Meseres involutus* Sluiter, 1901	Synallactidae
japonensis, Pseudostichopus (Trachostichopus), Imaoka, 1978	*Meseres hyalegerus* Sluiter, 1901	Synallactidae
lechleri, Thyone (Thyonidium), Lampert, 1885	*Trachythyone lechleri* (Lampert, 1885)	Cucumariidae
lionvillei, Cucumaria, Vaney, 1914	*Staurocucumis lionvillei* (Vaney, 1914)	Cucumariidae
macdonaldi, Meseres, Ludwig, 1894	*Meseres macdonaldi* Ludwig, 1894	Synallactidae
marenzelleri, Pseudostichopus, Hérouard, 1923	*Meseres peripatus* Sluiter, 1901	Synallactidae
mira, Cucumaria, Ludwig and Heding, 1935	*Staurocucumis lionvillei* (Vaney, 1914)	Cucumariidae
mollis, Pseudostichopus, Théel, 1886	*Pseudostichopus mollis* Théel, 1886	Synallactidae
molpadioides, Pseudostichopus, Ohshima, 1915	*Pseudostichopus molpadioides* Ohshima, 1915	Synallactidae
moseleyi, Stichopus, Théel, 1886	*Bathyplotes moseleyi* (Théel, 1886)	Synallactidae
navicula, Psolidium, Ekman, 1927	*Psolicrux coatsi* (Vaney, 1908)	Cucumariidae
nudus, Pseudostichopus, Ohshima, 1915	*Pseudostichopus nudus* Ohshima, 1915	Synallactidae
occultatus, Pseudostichopus, Marenzeller, 1893	*Meseres occultatus* (Marenzeller, 1893)	Synallactidae
peripatus, Meseres, Sluiter, 1901	*Meseres peripatus* Sluiter, 1901	Synallactidae

Table 1. Continued.

Original combination	Current combination or senior synonym	Family
pisanii, Chirodota, Ludwig, 1886	*Chiridota pisanii* Ludwig, 1886	Chiridotidae
plicatus var., *occultatus, Pseudostichopus*, Koehler and Vaney, 1905	*Meseres peripatus* Sluiter, 1901	Synallactidae
propinquus, Pseudostichopus, Fisher, 1907	*Meseres propinquus* (Fisher, 1907)	Synallactidae
racovitzai, Rhipidothuria, Hérouard, 1901	*Rhipidothuria racovitzai* Hérouard, 1901	Elpidiidae
robusta, Scotoplanes, Théel, 1882	*Amperima robusta* (Théel, 1882)	Elpidiidae
rubipunctatus, Bathyplotes, Gutt, 1990	*Bathyplotes gourdoni* (Vaney, 1914)	Synallactidae
spatha, Cucumaria, Cherbonnier, 1941	*Staurocucumis grandis* (Vaney, 1906)	Cucumariidae
spiculiferus, Meseres sp. nov.	*Meseres spiculiferus* sp. nov.	Synallactidae
steineni, Cucumaria, Ludwig, 1898	*Heterocucumis steineni* (Ludwig, 1898)	Cucumariidae
tachimaruae, Pseudostichopus (Trachostichopus), Imaoka, 1978	*Meseres hyalegerus* Sluiter, 1901	Synallactidae
torvus, Stichopus (?), Théel, 1886	*Meseres torvus* (Théel, 1886)	Synallactidae
trachus, Pseudostichopus, Sluiter, 1901	*Meseres trachus* (Sluiter, 1901)	Synallactidae
tuberculatus, Pseudostichopus (Trachostichopus), Imaoka, 1990	*Meseres peripatus* Sluiter, 1901	Synallactidae
turqueti, Cucumaria, Vaney, 1906	*Staurocucumis turqueti* (Vaney, 1906)	Cucumariidae
turricata, Thyone, Vaney, 1906	*Paracucumis turricata* (Vaney, 1906)	Paracucumidae
unguiculatus, Pseudostichopus, Ohshima, 1915	*Meseres peripatus* Sluiter, 1901	Synallactidae
villosus, Pseudostichopus, Théel, 1886	*Meseres villosus* (Théel, 1886)	Synallactidae
violaecuspidata, Achlyonice, Gutt, 1990	*Rhipidothuria racovitzai* Hérouard, 1901	Elpidiidae
vitjazi, Amperima, Gebruk, 1988	*Amperima vitjazi* Gebruk, 1988	Elpidiidae
wyvillethomsoni, Laetmogone, Théel, 1879	*Laetmogone wyvillethomsoni* Théel, 1879	Laetmogonidae

Type locality. Straits of Magellan.

Distribution. Magellanic region (from 42°S on the west and 43°S on the east of South America), Straits of Magellan, Falkland Is, South Georgia, Antarctic Peninsula, Antarctica at 88–89°E, Kerguelen and Marion and Prince Edward Is, 0–560 m (summaries by Pawson, 1964, 1969; Branch et al., 1993). Western Antarctica, Weddell Sea, 225–555 m (Gutt, 1991b). Eastern Antarctica, off Terre Adélie, 180–220 m (Cherbonnier, 1974); off Wilhelm II Land, 350–400 m (Ekman, 1927); off Wilkes and MacRobertson Lands, 101–216 m (this paper).

Remarks. In terms of tentacle number (12) and form (6–7 pairs of digits with the distal pair largest), ossicle distribution (wheels clustered, hooks spread), and ossicle form and size (wheels up to 0.17 mm diameter, sigmoid hooks up to 0.28 mm long, tentacle rods up to 0.27 mm long; lacking short rods in the longitudinal muscles), all of the material examined was consistent diagnostically and also with the descriptions by Théel (1886a) and H.L. Clark (1907). There were regional variations in ossicle size. Wheel diameter and hook length measurements of the BANZARE Kerguelen specimens were the same as the measurements given by Théel (1886a) for the *Challenger* Marion and Falkland material, and were respectively up to 0.12 and 0.28 mm. In the type locality material they were up to 0.17 and 0.21 mm; in the Wilkes material up to 0.14 and 0.26 mm. Ekman (1927) reported hooks to be 0.25 mm long in western Antarctic material; Deichmann (1947) reported wheels up to 0.12 mm and hooks up to 0.2 mm in Patagonia specimens; Pawson (1964) reported wheels up to 0.13 mm diameter and hooks up to 0.2 mm long in southern Chile material; and O'Loughlin et al. (1994) reported both hooks and wheels up to 0.2 mm in length and diameter for eastern Antarctic material (as *Taeniogyrus* cf. *contortus*). The variations are not considered here to be based on sufficient evidence for the establishment of separate species, but they do provide some evidence of morphological change occurring with the reproductive isolation of these viviparous populations. Further to the extensive synonymy and distribution summary by Pawson (1964, 1969), there have been reports of *T. contortus* for Terre Adélie by Cherbonnier

Table 2. Selected BANZARE Holothuroidea species list.

Taxon, Registration, Specimens	Location	Station
APODIDA		
Taeniogyrus contortus (Ludwig, 1875)		
SAM K1839 (1)	Kerguelen, 4-5 m	12
SAM K1840 (1)	Kerguelen, 2-20 m	49
ASPIDOCHIROTIDA		
Bathyplotes bongraini Vaney, 1914		
SAM K1836 (2)	Antarctica, off Kemp Land, 603 m	34
Meseres spiculiferus sp. nov.		
SAM K1850 (1)	Antarctica, off Enderby Land, 193 m	41
SAM K1851 (2)	Antarctica, Prydz Bay, 456 m	30
SAM K1852 (7)	Antarctica, off MacRobertson Land, 177 m	107
SAM K1853 (1)	Antarctica, off Wilkes Land, 695 m	98
Mesothuria bifurcata Hérouard, 1901		
SAM K1838 (1)	Antarctica, Prydz Bay, 1266 m	29
DENDROCHIROTIDA		
Heterocucumis godeffroyi (Semper, 1868)		
SAM K1844 (2)	Kerguelen, 47 m	59
SAM K1845 (2)	Kerguelen, 4-5 m	12
Heterocucumis steinenı (Ludwig, 1898)		
SAM K1832 (1)	Antarctica, off Enderby Land, 193-209 m	41
Staurocucumis liouvillei (Vaney, 1914)		
SAM K1848 (4)	Antarctica, off Kemp Land, 177 m	107
Trachythyone lechleri (Lampert, 1885)		
SAM K1849 (1)	Kerguelen, 47 m	59
Paracucumis turricata (Vaney, 1906)		
SAM K1846 (1)	Antarctica, off Wilkes Land, 474 m	97
ELASIPODIDA		
Amperima robusta (Théel, 1882)		
SAM K1842 (2)	North-east of Kerguelen, 3112 m	66
Rhipidothuria racovitzai Hérouard, 1901		
SAM K1829 (1)	Antarctica, off Enderby Land, 300 m	39
SAM K1830 (24)	Antarctica, off Enderby Land, 300 m	40
SAM K1831 (3)	Antarctica, off Wilkes Land, 474 m	97
Laetmogone wyvillethomsoni Théel, 1879		
SAM K1827 (1)	Antarctica, Prydz Bay, 540 m	30
SAM K1828 (1)	Antarctica, off Kemp Land, 603 m	34

(1974), for the Weddell Sea by Gutt (1991b), and for Marion and Prince Edward Is by Branch et al. (1993).

Order **Aspidochirotida** Grube

Synallactidae Ludwig

Bathyplotes bongraini Vaney

Bathyplotes bongraini Vaney, 1914: 5–8, pl. 1 fig. 4, pl. 2 figs 4, 7–9 and 11–12.

Bathyplotes moseleyi.—Ekman, 1925: 25–28, fig. 3.—Ekman, 1927: 371 [*non Bathyplotes moseleyi* (Théel, 1886a); not confirmed whether *B. bongraini* or *B. gourdoni*].

Bathyplotes fuscivinculum Gutt, 1990: 121–123, figs 4–6, tbl. II.—Gutt, 1991b: 324.—Gutt and Klages, 1991: 305 [new synonymy].

Bathyplotes sp. MoV 2018.—O'Loughlin et al., 1994: 553–554.

Material examined. Bathyplotes bongraini Vaney, 1914. Holotype. Western side of Antaretic Peninsula, 68°00′S, 70°20′W, 250 m, 1909, MNHN [extensively dissected, disintegrating; ossicles few, eroded, measurable].

Bathyplotes fuscivinculum Gutt, 1990. Paratype. Weddell Sea, 70°27′S, 8°40′W, 329–350 m, 1983 [ZIM E-7140 (1 specimen)] [no ossicles were detected].

Other material. Eastern Antarctica, off Kemp Land, 66°21′S, 58°50′E, 603 m, 1930 [BANZARE Stn 34,

Table 3. Selected diagnostic characters for *Meseres* species (x indicates present; – indicates absent; ? indicates unknown).

Species	distinct marginal projections	rounded longitudinal muscles	branched gonad tubules	gonad ossicles	respiratory tree ossicles	tentacle mesh ossicles
globigerinae	x	?	?	?	?	?
hyalegerus	–	x	–	–	–	–
involutus	x	–	x	–	–	x
macdonaldi	x	x	–	?	?	?
occultatus	x	x	–	–	x	–
peripatus	x	x	–	x	–	–
propinquus	x	x	–	x	x	?
spiculiferus	–	x	–	x	–	–
torvus	x	?	x	?	?	?
trachus	x	x	–	–	–	–
villosus	–	–	x	–	–	–

Table 4. Summary of significant new distribution data.

Taxon	Previous records (authors in text)	New records (this paper)
Chiridota pisanii Ludwig	Magellanic region	Heard Island
Bathyplotes bongraini Vaney	western Antarctica	eastern Antarctica
Bathyplotes gourdoni (Vaney)	western Antarctica	eastern Antarctica
Meseres hyalegerus Sluiter	Indonesia	Japan, south-eastern Australia
Meseres involutus Sluiter	Indonesia	eastern Australia, Tasman Sea
Meseres peripatus Sluiter	Indonesia	North Atlantic, Indo-Pacific
Meseres villosus (Théel)	Cosmopolitan, western Antarctica	eastern Antarctica
Mesothuria bifurcata Hérouard	western Antarctica, North Atlantic	eastern Antarctica
Heterocucumis godeffroyi (Semper)	Magellanic region, eastern Antarctica	Heard and Kerguelen Islands
Psolicrux coatsi (Vaney)	western Antarctica	off Bouvet Island
Staurocucumis lionvillei (Vaney)	Antarctica	Heard I.
Trachythyone lechleri (Lampert)	Magellanic, Heard Island	Kerguelen I.
Amperima robusta (Théel)	Antarctica, Kermadec Trench	southern Indian Ocean
Rhipidothuria racovitzai Hérouard	western Antarctica	eastern Antarctica
Laetmogone wyvillethomsoni Théel	Southern Ocean, western Antarctica	eastern Antarctica

SAM K1836 (2)]; Prydz Bay, 66°46′–68°55′S, 67°33′–78°14′E, 120–768 m [ANARE, NMV F68057 (1), F68070 (1), F68159–68160 (7), F68165 (1), F68167 (1), F68675 (1), F76574–76575 (2), F76577–76579 (3), F76587–76588 (2), F76599–76600(2), F80183 (2), F81796–81804 (37), F81818–81823 (42), F91299 (1)].

Distribution. Western Antarctica, Weddell Sea, 245–465 m (Gutt, 1991b, as *B. fuscivinculum*); western side of Antarctic Peninsula, 250 m (Vaney, 1914). Eastern Antarctica, Prydz Bay, 120–768 m; off Kemp Land, 603 m (this paper).

Remarks. Ekman (1925, 1927) considered *B. bongraini* to be a junior synonym of the non-Antarctic *B. moseleyi* (Théel). A distinctive diagnostic feature of *B. moseleyi* is the presence of raised round "warts" or "fungiform papillae" on the dorsolateral and ventrolateral interradii, and these are

not present in any of the Antaretic speeimens deseribed or examined in this study. On this basis the synonymy of *B. bongraini* with *B. moseleyi* by Ekman (1925, 1927) is rejected. The type locality of *B. moseleyi* (Théel, 1886a) is off southern Chile. Rowe (in Rowe and Gates, 1995) regarded *B. moseleyi* as a junior synonym of *B. natans* (Sars).

Gutt (1990) acknowledged difficulty in diagnosing difference between *B. rubipunctatus* and *B. fuscivinculum*, and depended on reeognition by live colour which is itself variable. Gutt and Klages (1991) acknowledged difficulty in distinguishing *B. rubipunctatus* and *B. fuscivinculum* from *B. moseleyi*. Based on the original descriptions and figures by Vaney (1914) and Gutt (1990), and the material examined, the distinctive features of *B. bongraini* are: large body size (up to 260 mm long); distinct ventrolateral brim with papillae; presenee of two midventral radial series of tube feet whieh are smaller and more numerous than in each of the lateroventral series; some bare ventral interradial areas; absence of warts; absence of C-shaped ossicles; table ossicle bases with predominantly four arms, very rarely up to six, arms up to 0.10 mm long [up to 0.07 in holotype; Vaney (1914) illustrated 0.07 mm; Gutt (1990) illustrated 0.12 mm and reported 0.13 mm]. The numbers of dorsal papillae and ventral tube feet vary with size, and the numbers given by Gutt (1990) for various sizes of *B. fuscivinculum* are comparable with numbers for ANARE material and the illustration of the holotype by Vaney (1914). The residual dark colour spots noted by Vaney (1914) are present on some of the ANARE material. *B. fuscivinculum* is judged here to be a junior synonym of *B. bongraini*, whieh is in turn distinct from *B. moseleyi* and other speeies of *Bathyplotes*. Ekman (1925, 1927) reported *B. moseleyi* from western and eastern Antarctica, but deseriptive detail is inadequate to distinguish whether the species was *B. bongraini* or *B. gourdoni*. *B. bongraini* oeeurs in eastern and western Antarctica.

Bathyplotes gourdoni (Vaney) comb. nov.

Synallactes (?) gourdoni Vaney, 1914: 4–5, pl. 2 figs 1–3, 5, 6.

Bathyplotes moseleyi.—Ekman, 1925: 25–28, fig. 3.—Ekman, 1927: 371 [*non Bathyplotes moseleyi* (Théel, 1886a); not confirmed whether *B. bongraini* or *B. gourdoni*].

Bathyplotes rubipunctatus Gutt, 1990: 120–121, figs 1–3, tbl. 1.—Gutt, 1991b: 324.—Gutt and Klages, 1991: 301–305, figs 1–3 [new synonymy].

Material examined. Bathyplotes rubipunctatus Gutt, 1990. Paratypes. Weddell Sea, 74°57′S, 60°31′W, 646–661 m [ZIM E7138 (3)] [no ossicles were detected].

Other material. Prydz Bay, 67°01′–68°01′S, 70°46′–77°19′E, 304–341 m [ANARE, NMV F68157 (1), F91296 (2)].

Distribution. Western Antaretiea, Weddell Sea, 225–840 m (Gutt, 1991b, as *B. rubipunctatus*); western side of Antarctic Peninsula, 250 m (Vaney, 1914). Eastern Antarctica, Prydz Bay, 304–341 m (this paper).

Remarks. Ekman (1925, 1927) considered the single very damaged type specimen of *S.* (?) *gourdoni*, collected close to the same location and depth as *B. bongraini*, to be conspecific with *B. bongraini* and then considered *B. bongraini* to be a junior synonym of the non-Antaretic *B. moseleyi* (Théel). The synonymy of *B. bongraini* with *B. moseleyi* is rejected above, and the synonymy of *S.* (?) *gourdoni* with *B. bongraini* is rejected here. Based on the original descriptions and figures by Vaney (1914) and Gutt (1990), and the material examined, the features which distinguish *S.* (?) *gourdoni* from *B. bongraini* are: smaller size (up to 120 mm long); residual pale pink preserved colour sometimes evident; gelatinous body wall, and consequent frequent loss of appendages; inconspicuous brim and ventrolateral edge; midventral radial tube feet sometimes extending onto ventral interradial areas, frequently creating a complete ventral cover; table ossicle bases with frequently four arms, up to eight and some branching, arms up to 0.20 mm long (Vaney, 1914, illustrated 0.12 mm; Gutt, 1990, illustrated 0.13 mm and reported 0.11 mm). *S.* (?) *gourdoni* is referred here to *Bathyplotes*, and *B. rubipunctatus* is considered here to be a junior synonym of *B. gourdoni*. *B. gourdoni* occurs in eastern and western Antarctica.

Meseres Ludwig

Meseres Ludwig, 1894: 34, 36, 38.—Perrier, 1902: 359.—Rowe (in Rowe and Gates, 1995): 284–285.—O'Loughlin, 1998: 497.

Molpadiodemas Heding 1935: 77–78.—Heding, 1940: 357.—Deichmann, 1940: 209–211.

Trachostichopus Heding, 1940: 357, 361.—Imaoka, 1978: 380.—Imaoka, 1990: 152.

Plicastichopus Heding, 1940: 357.—Heding, 1942: 5–6.

Comparative material examined. Pseudostichopus mollis Théel, 1886 [type species of *Pseudostichopus* Théel, 1886]. Syntype. Southern Ocean, off Marion I., 46°48′S, 37°49′E, 92–137 m, *Challenger* Stn 144a [BMNH 86.10.2.144 (1)].

Type species. Meseres macdonaldi Ludwig, 1894 [monotypy]; type locality: North Pacific Ocean, off Costa Rica (2149 m) and Colombia (1644 m).

Emended diagnosis. Up to 300 mm long; body wall soft, fragile; body rounded anteriorly and posteriorly, flat ventrally, convex dorsally, distinct lateroventral margin defined by acute angle or concentration of largest tube feet or series of pyramidal projections ("warts"); posterior vertical (pygal) furrow; mouth and anus ventral; calcareous ring solid, lacking posterior prolongations; up to 20 peltate tentacles; lacking tentacle ampullae; lacking retractor muscles; gonad tubules in 2 series on opposite sides of dorsal mesentery; respiratory trees well developed; radial tube feet very small, most conspicuous on ventrolateral margin; thin tubular appendages frequently present dorsally, laterally, ventrally, around mouth and anus, some branched, sometimes matted and entangled; ossicles present in tentacles and some tube feet, sometimes present in gonads and respiratory trees, absent from body wall except for large perforated plates or three-dimensional mesh ossicles sometimes present in posterior lobes; body frequently obscured by cover of sponge spicules or globigerines or detritus.

Species. M. globigerinae (Hérouard, 1923), *M. hyalegerus* Sluiter, 1901; *M. involutus* Sluiter, 1901; *M. macdonaldi* Ludwig, 1894; *M. occultatus* (Marenzeller, 1893); *M. peripatus* Sluiter, 1901; *M. propinquus* (Fisher, 1907); *M. spiculiferus* sp. nov.; *M. torvus* (Théel, 1886); *M. trachus* (Sluiter, 1901); *M. villosus* (Théel, 1886).

Distribution. Cosmopolitan, including Antarctic coast; bathyal and abyssal.

Remarks. The diagnostic characters of the type material are incompletely known, and are discussed below under *M. macdonaldi*. Unbranched or branched gonad tubules, rounded or broad flat longitudinal muscles, and the presence or absence of ossicles in gonads and respiratory trees, are considered here to be diagnostically significant within the genus (Table 3).

Determination of *Meseres* material is made difficult by: specimens completely obscured by an actively created cover (distinguished from passive adherence of substrate matter) of fur-like sponge spicules or globigerines or other detrital material; outer attached cover frequently lost during collecting, resulting in loss of outer body wall with tube feet and ventrolateral margin features; variable degree of development of "teeth" on the posterior edge of calcareous ring radial plates [observations in this work confirmed by illustrations for *Pseudostichopus (Trachostichopus) traehus* by Heding (1940)]; gonad tubules lost, or absent, and gonad ossicles sparse or absent in species in which gonad ossicles occur; ossicles in posterior lobes obscured amongst embedded detrital material; longitudinal muscles may or may not show evidence of longitudinal division within a species (type specimens of *M. involutus* have both grooved and ungrooved muscles).

A soft fragile body wall; lateroventral margin marked by pyramidal projections or a band of small tube feet or an acute angle; and thin tubular appendages around the mouth, in the pygal furrow, and over the body, distinguish *Meseres* from the closely-related genus *Pseudostichopus* Théel, 1886. The syntype of *P. mollis* (type species of *Pseudostichopus*) had a firm leathery body wall, was rounded in transverse section, lacked a distinct lateroventral margin, had very small tube feet present in sparse double series along the dorsolateral radii only, and lacked thin tubular appendages. Théel (1886a) was uncertain about the lateroventral distribution of tube feet in the syntypes of *P. mollis*, and referred to them as "more crowded in two to five (?) rows". This description is not valid for the syntype from off Marion I. There may be more than one species among the syntypes. A complete review of *Pseudostichopus* and *Meseres* and establishment of lectotypes for their species where necessary are beyond the scope of this work.

In a review of *Pseudostichopus* and related genera Heding (1940) did not include *Meseres*, and described a new genus *Plicastichopus* and the subgenera *Pseudostichopus* and *Trachostichopus* (for *Pseudostichopus*). Rowe (in Rowe and Gates, 1995) synonymised *Trachostichopus* Heding, 1940 and *Plicastichopus* Heding, 1940 with *Meseres*, assigning *Pseudostichopus (Trachostichopus) traehus* Sluiter, 1901 and *Plicastichopus ingolfi* Heding, 1942 to *Meseres*. Heding (1940) assigned *Pseudostichopus trachus* Sluiter, 1901, *P. propinquus* Fisher, 1907, *P. aleutianus* Ohshima, 1915, *P. arenosus* Ohshima, 1915, *P. molpadioides* Ohshima, 1915, and *P. mutus* Ohshima, 1915 to *Pseudostichopus (Trachostichopus)*. *P. propinquus* is assigned below to *Meseres*. *P. aleutianus* is synonymised below with *M. peripatus* Sluiter, 1901. *P. molpadioides* Ohshima, 1915 [off eastern Japan, 714 m], with probably junior synonym *P. arenosus* Ohshima, 1915 [off southern Japan, 781m], were described

as being cylindrical with a brown globigerine cover, distinct dorsolateral and ventrolateral tube feet, and spinous perianal ossicles. In the absence of a distinctive ventrolateral margin they are assigned to *Pseudostichopus*. A specimen taken off eastern Australia at 3500 m, held in the Australian Museum (AM J23009), has similar diagnostic characters. *P. nudus* Ohshima, 1915 was described as subcylindrical, lacking a distinct ventrolateral margin, and is assigned to *Pseudostichopus*. Heding (1940) referred *P. ingolfi* Heding, 1940 (ms.) and *P. plicatus* (Koehler and Vaney, 1905) to *Plicastichopus* Heding, 1940. Both species are synonymised below with *M. peripatus*.

Heding (1940) assigned *Pseudostichopus atlanticus* Perrier, 1898, *P. occultatus* Marenzeller, 1893 and *P. villosus* Théel, 1886 to *Molpadiodemas* Heding, 1935 (type species *M. acaudum* Heding, 1935). O'Loughlin (1998) synonymised *Molpadiodemas* with *Meseres*, and assigned *M. acaudum*, *P. atlanticus*, *P. occultatus* and *P. villosus* to *Meseres*. The assignment of *P. atlanticus* Perrier and *M. acaudum* Heding to *Meseres* is not in accord with the emended diagnosis of *Meseres* above, and these two species are synonymised and assigned below to *Pseudostichopus*.

Imaoka (1978, 1990) referred five new species to *Pseudostichopus*: *P. (Pseudostichopus) dilatorbis* Imaoka, 1978; *P. (Trachostichopus) tachimaruae* Imaoka, 1978; *P. (Trachostichopus) japonensis* Imaoka, 1978; *P. (Pseudostichopus) alatus* Imaoka, 1990; *P. (Trachostichopus) tuberculatus* Imaoka, 1990. *P. (Pseudostichopus) dilatorbis* [off south-western Japan, 400–450 m] lacked a distinctive ventrolateral margin and is appropriately referred to *Pseudostichopus*. *P. (Trachostichopus) tachimaruae* and *P. (Trachostichopus) japonensis* are synonymised below with *M. hyalegerus*. *P. (Pseudostichopus) alatus* [off southern Japan, 350 m] lacked a distinctive lateroventral margin and is confirmed as *Pseudostichopus*. This species is similar to *P. arenosus* and *P. molpadioides*, also reported off Japan by Ohshima (1915), but Imaoka (1990) did not find spiny perianal ossicles in *P. alatus*. *P. (Trachostichopus) tuberculatus* is synonymised below with *M. peripatus*.

The new combinations *Meseres globigerinae* and *M. torvus* are discussed below. *M. spiculiferus* sp. nov. and *M. villosus* occur on the eastern Antarctic coast. *M. trachus* and *M. villosus* have been reported by a number of authors (see below), but frequently with insufficient detail to confirm which species of *Meseres* was being reported. Ludwig (1894) determined North Atlantic material (2–6°N, 81–86°W, 245–3336 m) as *P. mollis*, but illustrated *peripatus*-like gonad ossicles which *P. mollis* lacks.

Meseres globigerinae (Hérouard) comb. nov.

Pseudostichopus globigerinae Hérouard, 1923: 23–25, pl. 4 fig. 6.—Mortensen, 1927: 386–388.—Deichmann, 1930: 87, 90.

Pseudostichopus (Pseudostichopus) globigerinae.—Heding, 1940: 353–360.—Imaoka, 1978: tbl. 1–1.—Thandar, 1992: 167.

Pseudostichopus villosus.—Hansen, 1956: 47–48 (part) [non *Meseres villosus* (Théel, 1886)].

Type locality. North Atlantic, Bay of Biscay, 4380 m.

Remarks. Features of *P. globigerinae* described by Hérouard (1923) were: up to 30 mm long; thin soft translucent body wall, covered with globigerines; pygal furrow; mouth and anus ventral; villous-like cover of unequal tube feet, except midventrally; posterior margin with tufts of tube feet on papillae; absence of ossicles. The description of the posterior margin indicates that diagnostically *P. globigerinae* is a *Meseres* species, and it is so assigned here. Hansen (1956) synonymised *P. globigerinae* with *P. villosus*, but the tufts of tube feet grouped on papillae along the posterior margin, cover of unequal tube feet, globigerine cover, and translucent body wall indicate that *P. globigerinae* is not *M. villosus* and it is removed from the synonymy here. The absence of descriptions of the form of the gonad tubules and longitudinal muscles, and presence or absence of ossicles in gonads and respiratory trees, leave any synonymy unresolved.

Meseres hyalegerus Sluiter

Meseres hyalegerus Sluiter, 1901a: 12.—Sluiter, 1901b: 50–51, pl. 5 figs 2–4.—Perrier, 1902: 359.

Pseudostichopus trachus.—Mitsukuri, 1912: 3–9, pl. 1 figs 1–5.—Ohshima, 1915: 227–228.—Mortensen, 1918: 80–81, fig. 16 [non *Meseres trachus* (Sluiter, 1901)].

Pseudostichopus (Trachostichopus) tachimaruae Imaoka, 1978: 380–382, fig. 2A–E, tbl. 1–2 [new synonymy].

Pseudostichopus (Trachostichopus) japonensis Imaoka, 1978: 382–384, fig. 3A–D, tbl. 1–2.—Imaoka, 1990: 148 [new synonymy].

Material examined. Syntypes. Indonesia, Banda Sea, 5°28′S, 132°00′E, 204 m, *Siboga* Stn 251 [ZMA 2177 (2 specimens)].

Other material. Sagami Sea, south of Honshu, 128–553 m [*Albatross* Stn 5092, USNM E17147 (47); Stns 4968, 5069, 5093, 5055, 5094, USNM 1001645–1001649 (15)]. Eastern Australia, Tasman Sea and Bass Strait, 293–530 m [NMV F80171 (2), F80172 (12), F80173 (1), F80174 (5), F80177 (1), F80178 (3), F80179 (3), F80180 (2), F80181 (19)].

Distribution. Indo-Pacific, Indonesia, Banda Sea, 204 m (Sluiter, 1901a); Japan, Sagami Sea, 141–564 m (Mitsukuri, 1912, as *P. trachus*); south of Honshu, 128–553 m (Ohshima, 1915, as *P. trachus*); eastern Australia, Tasman Sea and Bass Strait, 293–530 m (this paper).

Remarks. The syntypes of *M. hyalegerus* were collected at 204 m. Based on Sluiter (1901a, 1901b) and the syntypes studied, the features of *M. hyalegerus* are: largest was 100 mm long; all were covered with sponge spicules and other detrital matter, not predominantly globigerines; gonad tubules were unbranched, rarely bifid distally; lateroventral margin was subacute, and lacked small projections; ossicles comprising large open and close mesh bodies were present in the posterior lobes; tentacle ossicles were spinous rods up to 0.34 mm long, lacking a large central swelling and rarely branched. In contrast the syntypes of *P. trachus* (see below) were collected at 798–883 m; largest was 180 mm long; all were covered with globigerines; gonad tubules were long and thin; lateroventral margin was acute, with small projections ("warts"); ossicles were not detected in the posterior lobes; tentacle ossicles were thorny rods up to 0.20 mm long (0.13 mm in Sluiter, 1901b), frequently branched and with a central swelling. Material from the Sagami Sea, determined as *Pseudostichopus trachus* and described by Mitsukuri (1912), was collected at 141–564 m; largest was 120 mm long; all were covered with sponge spicules and other detrital material; gonad tubules were short, if branched only at the ends; no reference was made to lateroventral projections; close and open-mesh latticework ossicles were present posteriorly; tentacle ossicles (illustrated) were spinous rods, up to 0.30 mm long, lacking central swellings. The Sagami Bay specimens of Mitsukuri (1912) and Mortensen (1918), and the specimens from south of Honshu of Ohshima (1915), are considered here to be *M. hyalegerus*. Two species described by Imaoka (1978), *P. (Trachostichopus) tachimaruae* [off south-western Japan, 400–450 m] and *P. (Trachostichopus) japonensis* [off western Japan, 200–300 m], were both characterised by small size, dense cover of sponge spicules, dorsolateral and ventrolateral series of small tube feet, unbranched gonad tubules lacking ossicles, and mostly unbranched tentacle rods more than 0.2 mm long and lacking a distinct central swelling. Both species are synonymised here with *M. hyalegerus*. Sometimes tube foot rods were detected during this study in *M. hyalegerus* [reported for *japonensis* by Imaoka (1978)] and posterior ossicles [fragments reported for *tachimaruae* by Imaoka (1978)].

Meseres involutus Sluiter

Figure 2e

Meseres involutus Sluiter, 1901a: 11–12.—Sluiter, 1901b: 49–50, pl. 8 fig. 6.—Perrier, 1902: 359 (incorrectly as *convolutus*).

Material examined. Syntypes. Indonesia, Seram Sea, 3°27′S, 131°01′E, 567 m, *Siboga* Stn 173; Sawu Sea, 10°49′S, 123°23′E, 918 m, *Siboga* Stn 300 [ZMA (2)].

Other material. Eastern Australia, Tasman Sea, Lord Howe Rise, 1423 m [AM J23326 (1)]; off Newcastle, 2984–3058 m [AM J16833 (1)]; off Nowra, 1650–1750 m [NMV F80451 (1)].

Distribution. Indonesia, Seram and Sawu Seas, 567–918 m (Sluiter, 1901a); eastern Australia, Tasman Sea, 1423–3058 m (this paper).

Remarks. All five specimens were covered with globigerines, not sponge spicules. Most were covered with thin tubular appendages, most conspicuous laterally, smallest ventrally. The grey body wall with surface ridges and pockets and lumps, and finely serrated lateroventral margin created by transverse ridges, was similar to *M. peripatus*, but the marginal projections were not as pronounced as in some *M. peripatus* specimens. *M. involutus* is distinguished from *M. peripatus* by the form of the tentacle ossicles (include elongate, curved, distally tapered rods with mesh-like perforations); by branched gonad tubules; by broad flat longitudinal muscles; and by the absence of ossicles in the gonads. Posterior lobe ossicles were not detected. The longitudinal muscles were flat, some with two to three longitudinal grooves.

Meseres macdonaldi Ludwig

Meseres macdonaldi Ludwig, 1894: 34–36.—Perrier, 1902: 359.—Rowe (in Rowe and Gates, 1995): 284.—O'Loughlin, 1998: 497.

Material examined. Meseres macdonaldi Ludwig, 1894. Syntype. Northern Pacific Ocean, off Costa Rica, 5°56′N, 85°10′W, 2149 m, *Albatross* Stn 3362, 1891 [USNM 30501 (1)].

Type locality. North Pacific Ocean, off Costa Rica (2149 m) and Colombia (1644 m).

Remarks. The six syntypes of the type species *M. macdonaldi* are in an advanced stage of decomposition (C. Ahearn, USNM, pers. com.). Ludwig (1894) described maximum length as 30 mm; some covered with globigerines; body flattened dorsoventrally, with distinct edge; mouth and anus ventral; body wall thin, transparent; very small tube feet distributed thickly over whole body; 15 tentacles; tentacle ampullae absent; tufts of unbranched gonad tubules on both sides of dorsal mesentery; respiratory trees well-developed; longitudinal muscles undivided; ossicles not found in body wall or tube feet or tentacles. Ludwig (1894) did not report on ossicles in gonads or respiratory trees or posteriorly, and did not report a pygal furrow. In the syntype examined in this study no ossicles were found, and a pygal furrow was not evident in the disintegrating material. Two series of lateroventral pyramidal projections were present, each with about three very small digitate projections closely resembling the illustration of *S. torvus* by Théel (1886a) which was referred to by Ludwig (1894) in describing *M. macdonaldi*. There were very small tube feet and thin tubular appendages over the body. The longitudinal muscles were cylindrical. Gonad tubules were not detected.

M. occultatus, *M. peripatus* and *M. propinquus* share with *M. macdonaldi* having unbranched gonad tubules, rounded longitudinal muscles, and prominent lateroventral projections, but it is not possible to confirm any synonymy in the absence of observations on gonad and respiratory tree ossicles in *M. macdonaldi*.

Meseres occultatus (Marenzeller)

Pseudostichopus occultatus Marenzeller, 1893a: 15–17, pl. 4 fig. 9.—Marenzeller, 1893b: 10, pl. 2 fig. 3.—Perrier, 1902: 337–338.—Hérouard, 1902: 14–15, pl. 2 figs 4–14.—Mortensen, 1918: 81.—Mortensen, 1927: 387–388.—Deichmann, 1930: 89–90.

Molpadiodemas occultatus.—Heding, 1940: 353–359.

Meseres occultatus.—O'Loughlin, 1998: 497.

Material examined. Syntypes. Mediterranean Sea, 24°16′N, 35°03′E, 1445 m [MNHN EcHh 3658 (2)].

Distribution. Mediterranean Sea, 415–1445 m (Marenzeller, 1893a); North Atlantic, Spain, off Cape Finisterre, 363–510 m (Marenzeller, 1893b); bathyal.

Remarks. Based on the description and illustrations by Marenzeller (1893a, 1893b), and examination of two syntypes, two unique diagnostic characters for *M. occultatus* are the presence of branched ossicles in the respiratory trees, and not the gonads, and the presence of large posterior ossicles which are large partly double-layered perforated plates and not multilayered mesh. Otherwise the active attachment of detrital material; grey parchment-like body wall; reticulate outer body wall with lateroventral marginal projections; complete cover of thin tubular appendages; double series of small tube feet lateroventrally; rounded longitudinal muscles; unbranched gonad tubules; and form of ossicles in tube feet, are similar to *M. peripatus*. Hérouard (1902) determined material as *P. occultatus*, but subsequently (1923) referred the material to two new species (*P. marenzelleri* and *P. lapidus*). *P. marenzelleri* is synonymised below with *M. peripatus*. Deichmann (1930) determined an Atlantic specimen from Cuba (232 m) as *P. occultatus*, but described complex branched gonad ossicles. This character indicates that it was not *M. occultatus*, but data are insufficient to confirm any synonymy.

Meseres peripatus Sluiter

Figure 2f

Meseres peripatus Sluiter, 1901a: 10–11.—Sluiter, 1901b: 48–49, pl. 5 fig. 5, pl. 8 fig. 7.—Perrier, 1902: 359.—Rowe (in Rowe and Gates, 1995): 285.

Pseudostichopus occultatus.—Hérouard, 1902: 14–15, pl. 2 figs 4–14 (part, illustrated) [non *Meseres occultatus* (Marenzeller, 1893)].

Pseudostichopus occultatus var. *plicatus* Koehler and Vaney, 1905: 9–10, pl. 3 fig. 8, pl. 9 figs 1–3.—Heding, 1940: 353 [non *Meseres occultatus* (Marenzeller, 1893)].

Pseudostichopus aleutianus Ohshima, 1915: 228, pl. 8 figs 5a–e.—Imaoka, 1978: 380.

Pseudostichopus unguiculatus Ohshima, 1915: 230–231, pl. 8 fig 7a–e.—Imaoka, 1978: 384.—Rowe (in Rowe and Gates, 1995): 285 [synonymy by Rowe (in Rowe and Gates, 1995)].

Pseudostichopus marenzelleri Hérouard, 1923: 25.—Mortensen, 1927: 287–288.—Deichmann, 1930: 90.

Pseudostichopus (Pseudostichopus) marenzelleri.—Heding, 1940: 353–359.—Imaoka, 1978: tbl. 1–1.—Thandar, 1992: 167 [new synonymy].

Pseudostichopus (Pseudostichopus) unguiculatus.—Heding, 1940: 353–360.—Imaoka, 1978: tbl. 1–1.—Imaoka, 1990: 152.—Thandar, 1992: 167.

Pseudostichopus (Trachostichopus) aleutianus.—Heding, 1940: 353–359.—Imaoka, 1978: tbl. 1–2 [new synonymy].

Plicastichopus plicatus.—Heding, 1940: 354–359.—Heding, 1942: 6 [new synonymy].

Plicastichopus ingolfi Heding, 1942: 5–6, figs 4–5, pl. 1 figs 4–5.

Pseudostichopus (Trachostichopus) tuberculatus Imaoka, 1990: 149–152, pl. p. 149, fig. p. 151 [new synonymy].

Meseres ingolfi.—Rowe (in Rowe and Gates, 1995): 285 [new synonymy].

Material examined. Meseres peripatus Sluiter, 1901. Syntypes. Indonesia, Flores Sea, 7°24'S, 118°15'E, 794 m, *Siboga* Stn 45; Maluka Sea, 1°59'N, 125°01'E, 1200 m, *Siboga* Stn 122 [ZMA (2)].

Other material. Eastern Australia, Tasman Sea, off New South Wales, 823–1750 m [AM J20026 (2), J20027 (1), J22980 (9), J23219 (1), J23267 (2); NMV F80449 (1), F80450 (3), F90070 (2)].

Pseudostichopus unguiculatus Ohshima, 1915. Syntypes. Off southern Japan, 1058–1680 m, [*Albatross* Stns 4960, 5083, 5084, USNM E34151 (2), E24543 (1), E24544 (1)].

Pseudostichopus marenzelleri Hérouard, 1923. North Atlantic, 36°58' N, 26°20'W, 2871–2917 m [MNHN EcHh 6073 (1)].

Distribution. Indo-Pacific, Indonesia, Flores and Maluka Seas, 794–1200 m (Sluiter, 1901, as *M. peripatus*); Bay of Bengal, 3009 m (Koehler and Vaney, 1905, as *P. plicatus*); off southern Japan, 1058–1680 m (Ohshima, 1915, as *P. unguiculatus*), 660–700 m (Imaoka, 1990, as *P. tuberculatus*); Aleutian Is, 1019–1398 m (Ohshima, 1915, as *P. aleutianus*); eastern Australia, Tasman Sea, 823–1750 m (this paper). North Atlantic, off Greenland, 2137–3192 m (Heding, 1942, as *P. ingolfi*); between Portugal and the Azores, 4400 m (Hérouard, 1923, as *P. marenzelleri*).

Remarks. The features of *M. peripatus* shared by the material examined, and descriptions and illustrations of *Plicastichopus plicatus* (Koehler and Vaney, 1905), *Pseudostichopus aleutianus* Ohshima, 1915, *Pseudostichopus unguiculatus* Ohshima, 1915, *Pseudostichopus marenzelleri* Hérouard, 1923, *Plicastichopus ingolfi* Heding, 1942 and *P. (Trachostichopus) tuberculatus* Imaoka, 1990 are: up to 135 mm long; body normally covered with globigerines; body flat ventrally, domed dorsally, acute lateroventral margin with prominent serrations; body wall soft, thin, grey, semi-translucent; reticulate body ridges and large to small pockets, ridges with lumps and flaps with very small digitate projections, ridges projecting at margin to create prominent irregular pyramidal projections (conical warts); very small thread-like appendages variably present over whole body, prominent around mouth and anus, frequently massed, some branched; small radial tube feet, in irregular paired series dorsolaterally and lateroventrally (ventral to marginal projections), not detected midventrally; calcareous ring radial plates with minute teeth on posterior indentation; longitudinal muscles narrow, rounded, lacking divisions; up to 20 tentacles; gonad tubules unbranched; tentacle ossicles rods, frequently bluntly spinous, frequently with central swelling, rarely branched, up to 0.28 mm long; lateroventral tube feet with endplates up to 0.12 mm wide, comprising central irregular perforated plate intergrading with surrounding mesh of short nodular rods, sometimes with support rods up to 0.14 mm long; dorsolateral tube feet lacking endplates, with support rods up to 0.10 mm long; gonads with ossicles, commonly rods or X- or Y-shaped, smooth to spinous, up to 0.18 mm long, rarely irregularly branched with branches sometimes joined; ossicles absent from body wall, posterior lateral lobes, respiratory trees and thread-like appendages.

The diagnostic characteristic of *M. peripatus* is a combination of distinctive lateroventral body margin, and presence of ossicles in unbranched gonad tubules. The distinctive margin was illustrated by Sluiter (1901b, for *M. peripatus*), by Koehler and Vaney (1905, for *P. plicatus*), by Heding (1942, for *P. ingolfi*) and by Imaoka (1990, for *P. tuberculatus*). Ludwig (1894) referred to the illustration of *S. torvus* by Théel (1886a) in the description of *M. macdonaldi*. The type of *M. macdonaldi* has this distinctive margin, but data are insufficient to confirm a synonymy with *M. peripatus*. *M. involutus* has this form of margin to a lesser degree, but has branched gonad tubules lacking ossicles, and flat longitudinal muscles. *M. torvus* has this form of margin, but has branched gonad tubules and other data are insufficient to confirm a synonymy. The gonad ossicles are illustrated by Hérouard (1902, for *P. marenzelleri* as *P. occultatus*), by Koehler and Vaney (1905, for *P. plicatus*), by Ohshima (1915, for *P. aleutianus* and *P. unguiculatus*), and by Heding (1942, for *P. ingolfi*).

Hérouard (1902) incorrectly determined material from the North Atlantic as *P. occultatus* Marenzeller, but subsequently by his own admission (1923) described the material as the two species *P. marenzelleri* and *P. lapidus*. Hérouard (1902, as *P. occultatus*) illustrated *P. marenzelleri*, and showed branched ossicles in the gonads. The description of *M. villosus* (Théel) by Hérouard (1902) from the North Atlantic (3745–4360 m) refers to gonad ossicles in unbranched tubules, indicating that the material was not *M. villosus* [see below] and was possibly *M. peripatus*. But the size (up to 170 mm) and absence of the distinctive lateroventral margin make a synonymy uncertain. The North Atlantic specimen determined as *P. marenzelleri* (EcHh 6073) and examined here is identical in body

form with Indo-Pacific specimens of *M. peripatus*, but there were no gonad ossicles and the tentacle ossicles were significantly more irregularly branched than in *M. peripatus*. The determination is uncertain. Imaoka (1990) reported and illustrated tube foot plates and anal body wall ossicles for *P. tuberculatus* which are considered here to be not holothurian ossicles, and did not find ossicles in the gonad of the single specimen described (absence in a single specimen is not diagnostically reliable). The globigerine-covered grey translucent body with distinctive serrated margin, distribution of tube feet, form of gonad tubules and colour photo of the holotype are diagnostically identical with *M. peripatus*.

Mitsukuri (1912) conducted a detailed study of the holothurians of the Sagami Sea, and reported *Meseres hyalegerus* (as *P. trachus*) up to depths of 564 m and probably did not sample depths at which *M. peripatus* occurs. *M. peripatus* is reported off southern Japan at 1058–1680 m by Ohshima (1915, as *P. unguiculatus*) and at 660–700 by Imaoka (1990, as *P. tuberculatus*). *M. peripatus* is a deep bathyal to upper abyssal cosmopolitan species.

Meseres propinquus (Fisher) comb. nov.

Pseudostichopus propinquus Fisher, 1907: 691–693, pl. 71 fig. 3, pl. 72 fig. 2, pl. 73 fig. 3, pl. 74 fig. 1, pl. 76 fig. 3.—Imaoka, 1978: 382.—Rowe (in Rowe and Gates, 1995): 285.

Pseudostichopus (Trachostichopus) propinquus.—Heding, 1940: 357.—Imaoka, 1978: tbl. 1–1.—Imaoka, 1990: 148, 152.

Material examined. Holotype. Hawaiian Is, 21°11′N, 156°35′W, 518–519 m [USNM 21217].

Remarks. The holotype is in a very poor state of preservation. Based on the description and illustrations by Fisher (1907), this species has the characteristics of *Meseres* including a thin translucent body wall, acute lateroventral margin with mammiform tubercles, small radial tube feet, scattered very small thread-like appendages, and body cover of sponge spicules and foraminiferans. A unique diagnostic character is the presence of ossicles in both gonads and respiratory trees. Rowe (in Rowe and Gates, 1995) synonymised *P. propinquus* with *Pseudostichopus pustulosus* Sluiter, 1901. *P. pustulosus* lacks respiratory tree and gonad ossicles, and has multiple-branching gonad tubules (Sluiter, 1901a), and the synonymy is rejected here.

Meseres spiculiferus sp. nov.

Figures 1a–f, 2a–d

Pseudostichopus sp. MoV 2068.—O'Loughlin et al., 1994: 253–255.

Material examined. Holotype. Prydz Bay, 67°10′S, 74°28′E, 428 m, T. Bardsley, R. Ickeringill and C. Hayward, 6 Mar 1997, NMV F81857.

Paratypes (8). Prydz Bay, 66°46′–67°34′S, 70°42′–77°32′E, 298–540 m, 1991, 1997, NMV F68054 (1), F68156 (1), F72542 (1), F81805 (4), F81806 (1).

Other material. Eastern Antarctica, off Wilkes Land, 65°07′S, 107°29′E, 695 m, 1931 [BANZARE Stn 98, SAM K1853 (1)]; Prydz Bay, 66°48′S, 71°24′E, 456 m, 1929 [BANZARE Stn 30, SAM K1851 (2)]; off MacRobertson Land, 66°45′S, 62°03′E, 177 m, 1931 [BANZARE Stn 107, SAM K1852 (7)]; off Enderby Land, 65°48′S, 53°16′E, 193 m, 1930 [BANZARE Stn 41, SAM K1850 (1)]; Prydz Bay, Vincennes Bay, 65°33′–68°32′S, 70°20′–108°48′E, 290–600 m [ANARE, NMV F68153 (2), F68163 (1), F76598 (1), F81807 (4), F81813–81815 (3), F81824 (1), F81838–81840 (6), F81860 (1), F81862 (1), F82701 (1), F90071 (1)].

Description. Up to 105 mm long, 27 mm broad, 21 mm high; body wall soft, off-white; body normally covered with sponge spicules, sometimes globigerines; body flat ventrally, domed dorsally, rounded anteriorly and posteriorly, posterior pygal vertical furrow; mouth, anus ventral; lateroventral margin semi-acute, rounded, some reticulate ridges with very small digitate projections, lacking prominent ventrolateral projections; up to 20 reddish-brown tentacles; very small thread-like appendages variably present over whole body, typically 0.2 mm diameter, prominent around mouth and furrow, frequently entangled; small radial tube feet, up to 1.0 mm diameter, largest along lateroventral margin in band up to 5 very irregular rows wide continuous around anterior body, irregular double rows dorsolaterally, sparse to absent midventrally; longitudinal muscles rounded, undivided; single ventral polian vesicle; calcareous ring plates solid, more wide than high, lacking posterior prolongations, radials frequently with 4 posterior teeth on edge of indentation; ossicles in tentacles, tube feet, gonads, absent from body wall (including posterior lobes), respiratory trees; tentacle ossicles curved to straight rods up to 0.28 mm long, frequently with central rarely distal swellings, very rarely branched, rarely bluntly spinous; tube feet distal support rods up to 0.20 mm long, same form as tentacles; "endplates" up to 0.13 mm wide, open mesh of irregular thin knobbed branched rods;

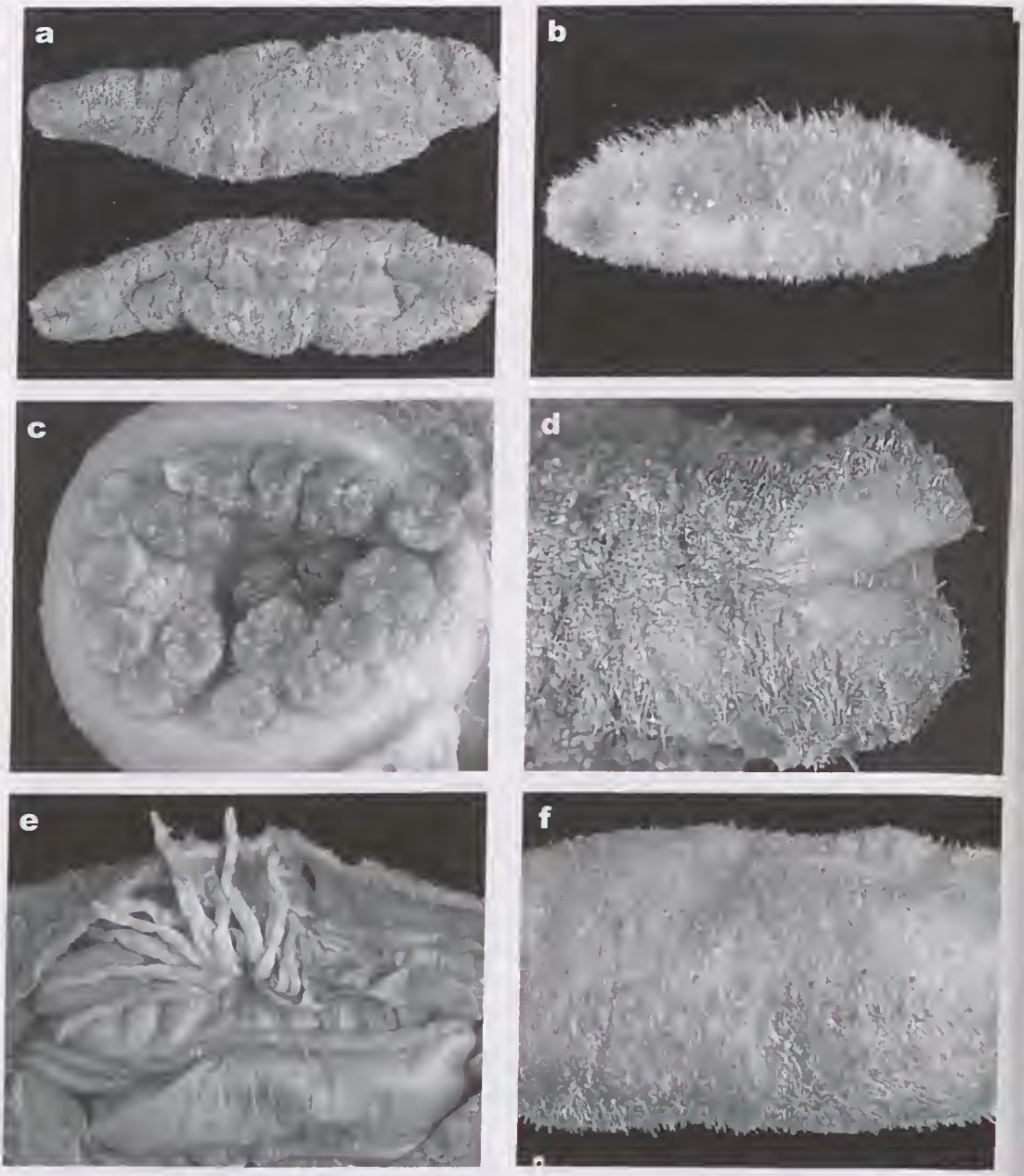

Figure 1. a–f, *Meseres spiculiferus* sp. nov. a. dorsal (above) and ventral (below) views of holotype (102 mm long); b, sponge cover, dorsal (paratype F68054, 30 mm long); c, tentacles (paratype F72542, specimen 83 mm long); d, pygal posterior furrow (paratype F81805, specimen 95 mm long); e, unbranched gonad tubules and rounded longitudinal muscles (paratype F81806, specimen 100 mm long); f, lateroventral tube feet (paratype F68156, specimen 54 mm long).

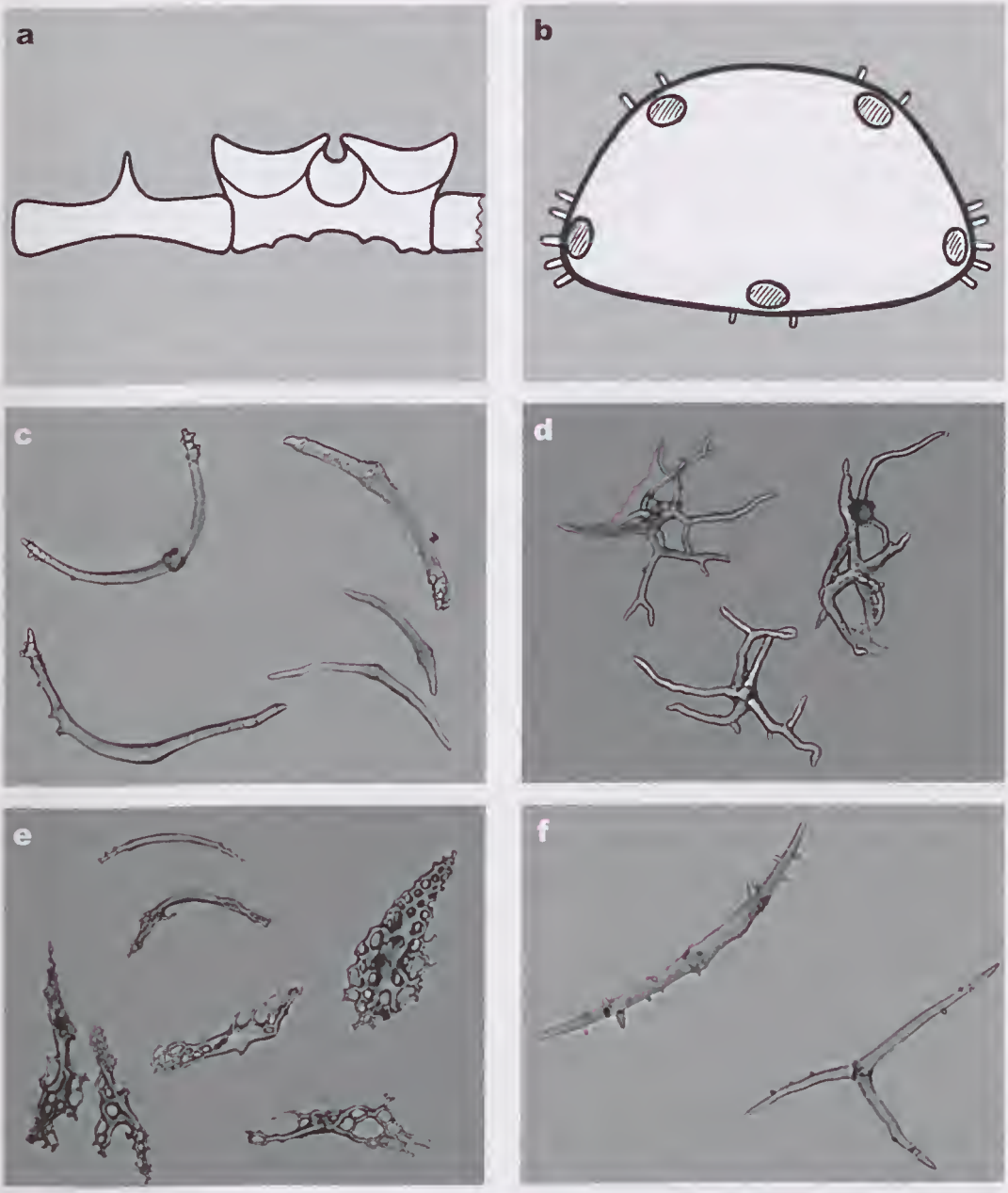

Figure 2. a–d, *Meseres spiculiferus* sp. nov. a, radial (right) and interradial (left) plates of calcareous ring; b, midbody section with tube feet distribution; c, tentacle ossicles (largest 0.22 mm across; BANZARE specimens); d, gonad ossicles (0.16 mm across; paratype F81806), e, *Meseres involutus* Sluiter. Tentacle ossicles (longest 0.30 mm long; F80451) f, *Meseres peripatus* Sluiter. Gonad ossicles (longest 0.20 mm long; F80450).

gonad tubules with abundant very irregular ossicles, frequently with large central swellings, rod to X- to Y-shaped to complex branching, branches sometimes joined to create large perforations, up to 0.30 mm long.

Etymology. From *spiculum* (Latin, sharp point) referring to sponge spicules, and *ferre* (Latin, to bear), describing the attached body cover of sponge spicules.

Distribution. Eastern Antarctica, off Wilkes, MacRobertson, Enderby Lands, 177–695 m.

Remarks. The distinguishing diagnostic characters of *M. spiculiferus* are very irregular ossicles in unbranched gonad tubules, absence of conspicuous lateroventral body wall projections, and narrow rounded and undivided longitudinal muscles. *Pseudostichopus atlanticus* Perrier, 1898 has similar gonad ossicles, but gonad tubules are branched and longitudinal muscles broad and flat. *M. peripatus* has gonad ossicles which overlap in form but are smaller (up to 0.18 mm long), and less branched; has smaller tube foot support rods (up to 0.14 mm long); and has prominent lateroventral marginal projections.

In the light of a general circumpolar occurrence of Antarctic holothurian species, and inadequate diagnostic detail recorded, material reported from western Antarctica as *Pseudostichopus mollis* Théel and *P. villosus* Théel was possibly *M. spiculiferus*. Gutt (1991a) reported that "sponge spicules adhere to the body wall of *Pseudostichopus villosus* giving it a furry appearance". This is not true of *M. villosus* in eastern Antarctica, and the description accurately fits *M. spiculiferus*.

Meseres torvus (Théel) comb. nov.

Stichopus (?) *torvus* Théel, 1886a: 164–165, pl. 10 figs 2–4.—Ludwig, 1894: 34.

Type locality. Southern Pacific Ocean, off Chile, 33°42′S, 78°18′W, 2516 m.

Remarks. This species is known from a single damaged specimen. Théel (1886a) described a wrinkled body covered with foreign matter, lateroventral conical projections, 20 tentacles, small crowded tube feet, solid calcareous ring lacking posterior prolongations, and absence of body wall ossicles. All are features of *Meseres*, to which *S. torvus* is assigned here. Gonad tubules were branched, and longitudinal muscles not divided. Reference was not made to ossicles in gonad tubules or respiratory trees or perianally, or to a pygal furrow which is presumed here to have been obscured by damage or the cover of foreign matter. Data are insufficient to confirm any synonymy.

Meseres trachus (Sluiter)

Pseudostichopus trachus Sluiter, 1901a: 15–16.—Sluiter, 1901b: 52–53, pl. 5 fig. 1, pl. 8 fig. 8.—Perrier, 1902: 337–338.—Fisher, 1907: 693.—Savel'eva, 1941: 74.—Djakonov, 1952: 127, 129.—Baranova, 1957: 239.—Djakonov et al., 1958: 366.—Imaoka, 1978: 384.—Cherbonnier and Féral, 1981: 383, 385, fig. 16.

Pseudostichopus (Trachostichopus) trachus.—Heding, 1940: 353–362, fig. 17.—Imaoka, 1978: tbl. 1–2.—Thandar, 1992: 166.

Meseres trachus.—Rowe (in Rowe and Gates, 1995): 285.—O'Loughlin, 1998: 497.

Material examined. Syntype. Indonesia, Arafura Sea, 8°50′S, 127°02′E, 883 m, *Siboga* Stn 286 [ZMA 2496.1 (1)].

Other material. Eastern Australia, Tasman Sea, 882–1198 m [AM J16836 (1), J23220 (1), J22957 (1), J22972 (1), J23218 (1); NMV F80175 (1), F80176 (1), F80448 (1)].

Distribution. Indo-Pacific, Indonesia, Arafura Sea, 798–883 m (Sluiter, 1901a); Philippines, 14°N, 120°E, 448–1125 m (Cherbonnier and Féral, 1981); Sea of Japan, 1600 m (Savel'eva, 1941); off Kuril Is, 113–560 m (Djakonov et al., 1958); Bering Sea, 110 m (Baranova, 1957); eastern Africa, off Kenya, 638–977 m (Heding, 1940); eastern Australia, Tasman Sea, 882–1198 m (this paper).

Remarks. Rowe (in Rowe and Gates, 1995) reassigned *P. traclus* to *Meseres*. Based particularly on the presence of a series of small but distinct lateroventral projections on a subacute ventrolateral margin, which were noted by Sluiter (1901b) and observed here on the type, the reassignment is supported here. Diagnostic characters for *M. traclus* are discussed under *M. hyalegerus* above. There is an absence of reference to other *Meseres* species, such as *M. hyalegerus*, and insufficient diagnostic data in the reports of *P. traclus* by Heding (1940), Savel'eva (1941), Baranova (1957), Djakonov et al. (1958) and Cherbonnier and Féral (1981), to confirm their determinations. Depths as shallow as 110 m (Baranova, 1957) and 113 m (Djakonov et al., 1958), complete sponge spicule cover (Savel'eva, 1941), and specimens up to 300 mm long (Djakonov et al., 1958), raise doubts about the determinations. Mitsukuri (1912) and Ohshima (1915) reported *P. traclus* for Japan, but their material is considered above to be *M. hyalegerus*.

Meseres villosus (Théel)

Figures 3a–b

Pseudostichopus villosus Théel, 1886a: 170–171.—Ludwig, 1898a: 8.—Perrier, 1902: 337–338.—Hérouard, 1902: 11–14, pl. 2 figs 1–3, pl. 7 fig. 3.—Vaney, 1908: 407–408.—Grieg, 1921: 4.—Hérouard, 1923: 23.—Mortensen, 1927: 387–388.—Deichmann, 1930: 89.—Hansen, 1956: 47–48, 51–53.—Gutt, 1991b: 324.

Pseudostichopus villosus var. *violaceus* Théel, 1886a: 172, pl. 10 fig. 6b.

Molpadiodemas villosus.—Heding, 1940: 353–360.

Pseudostichopus sp. MoV 2033.—O'Loughlin et al., 1994: 253–254.

Meseres villosus.—O'Loughlin, 1998: 497.

Material examined. Syntype. Southern Ocean, 46°16′S, 48°27′E, 2928 m, *Challenger* Stn 147 [BMNH 86.10.2.154 (1)].

Other material. Eastern Antarctica, Prydz Bay, 66°46′–68°50′S, 72°14′–77°19′E, 333–765 m [ANARE, NMV F68152 (9), F68158 (1), F68162 (5), F72534 (2), F76583 (2), F76597 (1), F76606 (1), F81816–81817 (3)].

Type locality. Syntypes (11) from Atlantic, Indian, Pacific and Southern Oceans; abyssal.

Distribution. Atlantic, Indian, Pacific and Southern Oceans, 2516–5307 m (Théel, 1886a). Western Antarctica, Weddell Sea, 4575–4795 m (Vaney, 1908); 405–465 m (Gutt, 1991b). Kermadec Trench, 6660–7000 m (Hansen, 1956); North Atlantic, 34°59′ N, 33°01′W, 2615–2965 m (Grieg, 1921). Eastern Antarctica, Prydz Bay, 333–765 m (this paper).

Remarks. The distinctive characteristics of *M. villosus* are: up to 150 mm long; subcylindrical form; absence of a cover of sponge spicules or globigerines or detrital matter; broad band of numerous larger tube feet lateroventrally (up to 2 mm long); lacking thin tubular appendages; broad flat undivided longitudinal muscles; multiple branching gonad tubules; absence of ossicles in tube feet, gonad tubules, respiratory trees, posteriorly; dark reddish-brown body colour. Deichmann (1930) thought that material off Morocco determined by Hérouard (1902) as *P. villosus* was probably *P. atlanticus*, but Hérouard (1902) described rod ossicles in unbranched gonad tubules which suggests *M. peripatus* [see above]. Deichmann (1930) determined material from the French West Indies (896 m) as *P. villosus*, but described tube feet in bundles on distinct lateral conical warts. This feature and the shallow bathyal depth indicate that the material was not *M. villosus*. Hansen (1956) synonymised *P. globigerinae* with *P. villosus*, but it is removed here from the synonymy [see above]. This cosmopolitan abyssal species occurs at shallow bathyal depths around the Antarctic coast.

Mesothuria bifurcata Hérouard

Mesothuria bifurcata Hérouard, 1901: 40.—Hérouard, 1906: 4–6, pl. 2 fig. 3.—Heding, 1942: 8, fig. 7.—O'Loughlin et al., 1994: 553–4.

Material examined. Holotype. Western Antarctica, Bellingshausen Sea, 71°14′S, 89°14′W, approximately 800 m (estimated from given latitude and longitude), 1898 [IRSNB IG 10131].

Other material. Eastern Antarctica, off Princess Elizabeth Land. 66°28′S, 72°41′E, 1266 m, 1929 [BANZARE Stn 29, SAM K1838 (1 specimen)]; Prydz Bay, 66°46′–68°32′S, 70°41′–77°19′E, 320–743 m [ANARE, NMV F68050 (1), F68154 (1), F72540 (3), F76594–76596 (3), F81808–81812 (38), F81858–81859 (5), F81861 (1), F81863 (2)].

Distribution. Western Antarctica, Bellingshausen Sea, 800 m (Hérouard, 1901). Eastern Antarctica, off Princess Elizabeth Land, Prydz Bay, 320–1266 m (this paper). North Atlantic, 61°44′N, 30°29′W, 2337 m (Heding, 1942).

Remarks. The holotype has shrunken to 4.6 mm long, and is in poor condition. No ossicles were found. The ANARE material is consistent with the holotype and the descriptions and figure by Hérouard (1901, 1906). The ANARE specimens have the following characteristics: up to 70 mm long, subcylindrical, rounded anteriorly, slightly tapered posteriorly, mouth ventral, anus posterior; lacking pygal furrow, anal teeth; body wall thick, firm, flexible; preserved colour grey to reddish-brown dorsally, darker ventrally; up to 20 reddish-brown peltate tentacles; gonad tubules with multiple branching; longitudinal muscles divided; largest tube feet in single ventrolateral row, smaller tube feet in row lateral to ventrolateral row; very small tube feet scattered dorsally, laterally, few ventrally, absent midventrally; calcareous ring solid, lacking posterior prolongations, radial plates as high as wide with anterior V-shaped notch, interradial plates at least twice as wide as high; all of body surface with close bristle of table spires; form of table ossicles variable, normally height of spire similar to width of disc; largest discs with three large, three smaller perforations, angular margin, up to 0.23 mm wide; smaller discs less regular, typically nine perforations, more rounded margin, typically 0.08 mm wide; spires with three pillars, joined proximally and distally, extending into radiating tapered spines, height of spires variable up to 0.18

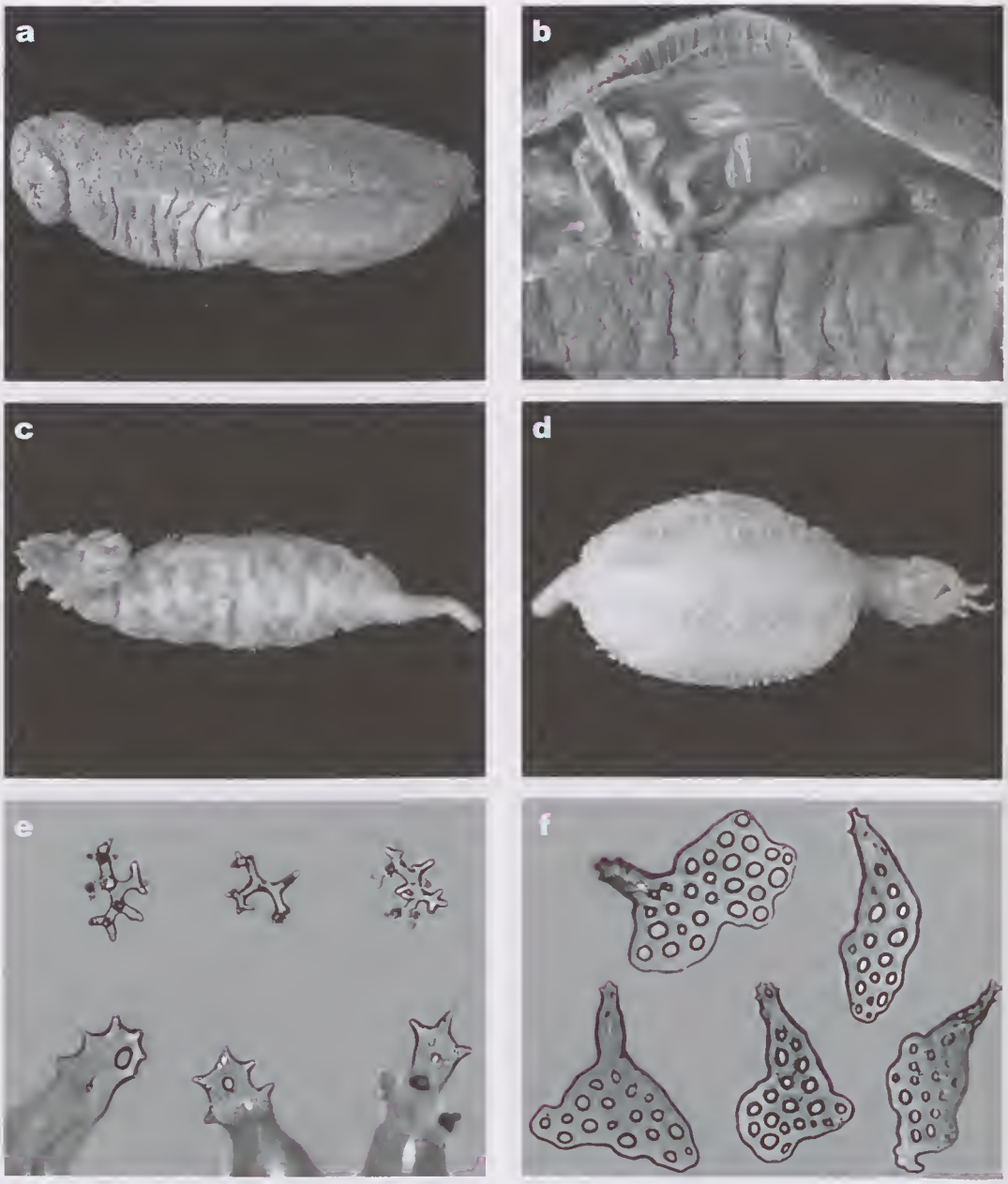

Figure 3. a–b, *Meseres villosus* (Théel), specimen F81816, 88 mm long. a, lateroventral tube feet; b, branched gonad tubules and broad flat longitudinal musele. e–f, *Psolicrux coatsi* (Vaney). c, tentacles and elongate thin tail (F68044, 39 mm long); d, sole-like ventrum (F68047, specimen 33 mm long); e above, knobbed crosses (0.07 mm long; F72614); e below, plate spires (F68084); f, spired plates (largest 0.51 mm long; F68084).

mm; radiating spines variable with single point, or up to four terminal spinelets, or strongly bifurcate with or without terminal spinelets, or doubly bifureate.

The deseription and illustrations of the single North Atlantic *Ingolf* specimen by Heding (1942) are also consistent diagnostically with the ANARE material, including table size (illustrated dise 0.12 mm wide, spire 0.13 mm high) and the oeeurrence of doubly bifureate spines minutely spinous distally. Gutt (1991b) reported *Mesothuria lactea* (Théel, 1886) from the Weddell Sea, but did not report *M. bifurcata*. Ossicles are similar, exeept for the frequently bifureate spines at the ends of the table spires. Weddell Sea material was probably *M. bifurcata*. This near abyssal Atlantic oecurrenee and shallow bathyal occurrence near the Antarctie eontinent are eomparable with the distribution of *Meseres villosus* Théel. The BANZARE and ANARE speeimens extend the distribution to eastern Antarctica.

Pseudostichopus atlanticus Perrier

Pseudostichopus atlanticus Perrier, 1898: 1665.—Perrier, 1902: 333–338, pl. 17 figs 15–20.—Mortensen, 1927: 386–387.—Deichmann, 1930: 87–88.—Deichmann, 1940: 209, 211.—Heding, 1942: 5.

Molpadiodemas acaudum Heding, 1935: 78–80, pl. 6 figs 1–2.—Heding, 1940: 354–357.—Deichmann, 1940: 209, 211.—Heding, 1942: 4–5.

Molpadiodemas atlanticus.—Heding, 1940: 353–359.

Meseres atlanticus.—O'Loughlin, 1998: 497.—Thandar, 1999: 376–379, fig. 4.

Meseres acaudum.—O'Loughlin, 1998: 497, fig. 1 g–h [new synonymy].

Material examined. Pseudostichopus atlanticus Perrier, 1898. Holotype, paratype. North Atlantic, off the Azores, 42°19′ N, 23°36′W, 4060 m, *Talisman* Stn 134, 1883 [MNHN EcHh 2772, EcHh 658].

Molpadiodemas acaudum Heding, 1935. Paratype. North Atlantic, 60°17′ N, 54°05′W, 3230 m, *Ingolf* Stn 37, 1895 [ZMUC].

Distribution. North Atlantic, 3230–4060 m (Perrier, 1902, as *P. atlanticus*; Heding, 1935, as *M. acaudum*); South Atlantic, off South Africa, 34°42′S, 16°54′E, 3155–3255 m (Thandar, 1999); abyssal.

Remarks. Heding (1940) referred *Pseudostichopus atlanticus*, *P. villosus* and *P. occultatus* to *Molpadiodemas* Heding, 1935 (type speeies *M. acaudum*). O'Loughlin (1998) synonymised *Molpadiodemas* with *Meseres*. Both *P. atlanticus* and *M. acaudum* laek a distinctive ventrolateral margin, and do not belong in the emended diagnosis of *Meseres* above. The two speeies are reassigned to *Pseudostichopus*. Deichmann (1940) and Heding (1942) considered that *P. atlanticus* and *M. acaudum* might be synonymous. The types of both speeies were taken at abyssal depths in the North Atlantic; are pale brown in colour, with very small brown spots (eollapsed papillae); have a large sac-like form, very rugose ventrally, with some globigerines attaehed; have a thiek body wall laeking a ventrolateral margin; have a eover of very small tube feet, frequently withdrawn; have very broad flat longitudinal museles; have braneheđ gonad tubules with complex ossieles; and laek ossieles in tube feet and respiratory trees. *Molpadiodemas acaudum* Heding, 1935 is eonsidered here to be a junior synonym of *Pseudostichopus atlanticus* Perrier, 1898. *Meseres peripatus*, *M. propinquus* and *M. spiculiferus* also have ossieles in the gonads. *P. atlanticus* is distinguished from *M. peripatus* which has unbraneheđ gonad tubules, projections on the lateroventral margin, and rounded longitudinal muscles. *M. propinquus* has ossieles in the respiratory trees, marginal projeetions, rounded longitudinal muscles, and unbraneheđ gonad tubules. *P. atlanticus* and *M. spiculiferus* have similar complex gonad ossicles, but *M. spiculiferus* has unbraneheđ gonad tubules and rounded longitudinal muscles. Deichmann (1930) deseribed a speeimen of *P. atlanticus* from the British West Indies (2920 m) as having narrow, undivided, eircular muscle bands, whieh indicates probable misidentification. The rounded body form and braneheđ gonad tubules and broad longitudinal museles of *P. atlanticus* are similar to *M. villosus* which is distinguished by a prominent band of ventrolateral tube feet, and by laeking gonad ossicles. The "mulberry" bodies from the body wall of *P. atlanticus*, illustrated by Perrier (1902) and Thandar (1999), and referred to by Théel (1886a) as present in some specimens of *P. villosus*, are considered here to be detrital aeerections and not holothurian ossieles and species speeifie.

Order **Dendroehirotida** Grube

Cucumariidae Ludwig

Heterocucumis Panning

Ekmocucumis (Heterocucumis) Panning, 1949: 452.

Type species. Cucumaria steineni Ludwig, 1898 [original designation].

Emended diagnosis. Ten equal tentacles; tube feet on larger speeimens in more than single radial rows; ealeareous ring laeks posterior prolongations, frequently soft or absent with age;

significant change in ossicle form with age; plates with narrow extension at some developmental stage; plates in larger specimens single-layered, perforated; some plates with one spinous edge or spinous tapered end or marginal pointed projections; plates with surface spines; lacking tables, cups and crosses; lacking towered crosses at any developmental stage.

Species. H. denticulata (Ekman, 1927); *H. godeffroyi* (Semper 1868); *H. steineni* (Ludwig, 1898).

Distribution. Antarctica, Magellanic region, Kerguelen region.

Remarks. Heding (1942) nominated *Cucumaria turqueti* Vaney, 1906b as type species for his new genus *Ekmocucumis*. Panning (1949) created two subgenera of *Ekmocucumis: Ekmocucumis* (type species *Cucumaria turqueti*), and *Heterocucumis* (type species *Cucumaria steineni*). Based on very close similarity of developmental changes in ossicle form, Hansen (1988) supported the original thinking of Ekman (1927) and assigned *Cucumaria liouvillei* Vaney, 1914, *C. abyssorum* Théel, 1886a and *C. turqueti* Vaney, 1906b to *Staurocucumis* Ekman, 1927 (type species *C. liouvillei*). Massin (1994) followed Hansen (1988). Thus the type species (*Cucumaria turqueti*) of the genus and subgenus *Ekmocucumis* Heding, 1942 has been assigned to *Staurocucumis*, the genus name *Ekmocucumis* becoming a junior synonym. The subgenus *Heterocucumis* Panning, 1949 is raised here to generic status.

Cucumaria grandis Vaney, 1906b was considered by Ekman (1925, 1927) to be a junior synonym of *Cucumaria turqueti* [*C. grandis* has page precedence over *C. turqueti* in Vaney 1906b, but the relegation of *C. grandis* to junior synonymy by Ekman (1925) stands under the "Principle of the First Reviser" (ICZN Article 24a)]. Cherbonnier (1974) retained *Ekmocucumis grandis* (junior synonym *Cucumaria spatha* Cherbonnier, 1941b). With a probable synonymy [adequate comparative material not yet examined] of *E. grandis* with *S. turqueti*, the former is provisionally referred here to *Staurocucumis*.

Of the three species (*coatsi, denticulata, steineni*) originally assigned by Panning (1949) to his new subgenus *Heterocucumis, denticulata* and *steineni* are retained here in *Heterocucumis*, and *coatsi* is referred below to a new genus *Psolicrux*. *C. godeffroyi* is referred here to *Heterocucumis* on the basis of: ten subequal tentacles; radial double rows of tube feet; elongate perforated plates with spinous surface and pointed marginal projections, some plates with one end narrow and spinous in smaller specimens; significant ossicle change during development (Ludwig, 1898b; Pawson, 1969); and tendency to lose the calcareous ring with age. Although body wall ossicles in large specimens of *H. godeffroyi* are significantly smaller than in large specimens of *H. steineni*, they are indistinguishable from the small ossicles present in *H. steineni*. Both species have a leathery non-calcareous body wall, tend to lose the calcareous ring with size, have a maximum size of about 70 mm, and have dark brown colouration anteriorly.

Heterocucumis godeffroyi (Semper) comb. nov.

Cucumaria godeffroyi Semper, 1868: 53, pl. 15 figs 12, 14.—Lampert, 1885: 144.— Théel, 1886a: 99–100.—Ludwig, 1898b: 435–437, pl. 26 figs 15–21.—H.L. Clark, 1910: 352–353.—Ekman, 1925: 49.—Deichmann, 1941: 83–84.—Deichmann, 1947: 334.—Panning, 1955: 43–45, figs 7–9.—Pawson, 1969: 131–133, fig. 1.

Stereoderma godeffroyi.—Panning, 1949: 422.—Pawson, 1964: 457.

Material examined. Kerguelen region, Kerguelen I., Royal Sound, 49°28′S, 70°04′E, 4–5 m, 1929 [BANZARE Stn 12, SAM K1845 (2 specimens)]; 49°28′S, 70°12′E, 47 m, 1930 [BANZARE Stn 59, SAM K1844 (2)]; Heard I., 51°16′–53°12′S, 73°05′–76°02′E, 200–379 m [ANARE, NMV F84996 (1), F84999–85001(3)].

Type locality. Chile, Iquique.

Distribution. Magellanic region, Chile, 0–60 m (summary by Pawson, 1969). Kerguelen region, Kerguelen and Heard Is, 4–379 m (this paper).

Remarks. Panning (1949) assigned *C. godeffroyi* to *Stereoderma* Ayres, but subsequently (1955) provided a description of *Cucumaria godeffroyi*, implicitly returning the species to *Cucumaria*. Panning (1964) formally regarded *Stereoderma* as monotypic, excluding *C. godeffroyi*.

The sparse flat perforated plates with spinous surface and pointed marginal projections are commonly 0.06 and up to 0.10 mm long in larger Heard and Kerguelen specimens, and up to 0.14 mm long in smaller specimens. Pawson (1969) reported plates in larger specimens from off Chile as larger (average 0.17 mm long). The change in ossicle form with size reported and illustrated by Pawson (1969) is evident in the Heard and Kerguelen material, and the dark brown colour around the base of the tentacles is present in some Heard specimens.

This species is not *Cucumaria godfroyi* Vaney, 1914, which Ekman (1925, 1927), Panning (1949) and Massin (1994) regarded as a junior

synonym of *Ekmocucumis steineni* (Ludwig), now *Heterocucumis steineni* (below). This paper reports an extension of the distribution of *H. godeffroyi* from the Magellanic to Kerguelen region, at a generally greater depth. It has not been reported from the Antarctic coast.

Heterocucumis steineni (Ludwig)

Cucumaria steineni Ludwig, 1898a: 30–32, pl. 2 figs 22–24.—Ekman, 1925: 38–45, fig. 6.—Ekman, 1927: 363, 390–393, figs 12, 13.—Panning, 1936: 15–16, figs 6, 7.—Cherbonnier, 1941a: 464–468.

Cucumaria antarctica Vaney, 1906b: 6–10, figs 3, 8, 26.—Vaney, 1908: 427.—Vaney, 1914: 8–9.

Cucumaria godfroyi Vaney, 1914: 11–12, pl. 4 figs 1–5.

Ekmocucumis (Heterocucumis) steineni.—Panning, 1949: 452–453, fig. 51.

Heterocucumis antarctica.—Cherbonnier, 1974: 609.

Heterocucumis godfroyi.—Cherbonnier, 1974: 609.

Ekmocucumis steineni.—Gutt, 1991b: 324.—O'Loughlin et al., 1994: 549, 554.

Heterocucumis steineni.—Massin, 1994: 130–145, figs 5–16.

Ekmocucumis sp. MoV 2005.—O'Loughlin et al., 1994: 551–552, 554.

Material examined. Antarctica, off Enderby Land, 65°48′S, 53°16′E, 193–209 m, 1930 [BANZARE Stn 41, SAM K1832 (1)]; Prydz Bay, off Enderby and MacRobertson Lands, 66°53′–68°31′S, 65°26′–78°13′E, 105–743 m [ANARE, NMV F68024 (1), F68030 (2), F68053 (1), F68100 (3), F68678 (1), F69109 (1), F69111 (1), F72615 (4), F91297 (27)].

Type locality. South Georgia.

Distribution. Western Antarctica, South Orkney Is, South Georgia, Falkland Is and Burdwood Bank, 2–400 m (summary by Ekman, 1927); off Graham Land, 0–110 m (Vaney, 1906b, as *C. antarctica*); off Alexander I., 6–297 m (Vaney, 1914, as *C. antarctica* and *C. godfroyi*); Weddell Sea, 160–1180 m (Gutt, 1991b). Eastern Antarctica, off Terre Adélie, 6–210 m (Cherbonnier, 1974, as *H. antarctica* and *H. godfroyi*); off Wilhelm II Land, 350–400 m (Ekman, 1927); off Enderby and MacRobertson Lands, 105–743 m (this paper).

Remarks. Ekman (1927) considered *C. antarctica* and *C. godfroyi* to be junior synonyms of *C. steineni*. Cherbonnier (1941a, 1974) rejected the synonymies by Ekman (1927), and reported *Heterocucumis antarctica* (Vaney) and *Heterocucumis godfroyi* (Vaney) for Terre Adélie. Massin (1994) supported the synonymies after a study of developmental changes in ossicle form. Determination of *H. steineni* in this study is based on the illustrations of variation in ossicle form with size by Massin (1994). Material determined as *Ekmocucumis* sp. MoV 2005 by O'Loughlin et al. (1994) comprises mostly larger specimens of *H. steineni*.

Psolicrux gen. nov.

Type species. Psolidium coatsi Vaney, 1908.

Diagnosis. Body wall thin, calcareous; mouth anterior on short taper; anus posterior on elongate tapered tail; 10 subequal dendritic tentacles; calcareous ring lacking posterior prolongations; mid-body ventral radial tube feet larger than those extending to introvert and anus, creating sole-like ventrum; scattering of dorsal and lateral tube feet beyond dorsolateral radial series; body wall ossicles plates and knobbed crosses; plates irregularly oval, typically 0.44 mm long in western Antarctica (0.60 mm in eastern Antarctica), perforated, smooth surface and margin, one end tapered into narrow, sometimes perforated, distally spinous spire angled above plate surface; crosses small, typically 0.08 mm long in western Antarctica (0.06 mm in eastern Antarctica), not cupped, with irregular short frequently distally knobbed branches; lacking tables and cups.

Etymology. From a family name Psolidae, referring to the sole-like ventrum, and crux (Latin for cross), referring to the knobbed crosses.

Remarks. Psolicrux is distinguished from other genera of Cucumariidae by a combination of elongate thin tail, sole-like ventrum, scattered dorsal and dorsolateral tube feet, smooth perforated plates with angled spinous spires, and irregular knobbed crosses.

Psolicrux coatsi (Vaney) comb. nov.

Figures 3e–f

Psolidium (Cucumaria) coatsi Vaney, 1908: 424–425, pl. 4 figs 47–50.

Cucumaria conspicua Vaney, 1908: 433, pl. 2 figs 15–16, pl. 5 fig. 67.—Ekman, 1927: 414.—Panning, 1949: 416 [new synonymy].

Psolidium navicula Ekman, 1927: 408–414, fig. 18.—Panning, 1949: 455.—Gutt, 1991b: 324 [new synonymy].

Psolidium bistriatum Ludwig and Heding, 1935: 165–167, figs 30–31.—Panning, 1949: 455 [new synonymy].

Ekmocucumis (Heterocucumis) coatsi.—Panning, 1949: 452.

Heterocucumis coatsi.—Cherbonnier, 1974: 609.

Ekmocucumis sp. MoV 2013.—O'Loughlin et al., 1994: 549.

Material examined. Western Antarctica, Weddell Sea, 115 m, 1958 [USNM E51318 (7 specimens)]; South Sandwich Is, 415–613 m, 1975 [USNM E51314 (1)]; South Shetland Is, 97–113 m, 1966 [USNM E51317 (2)]; Palmer Archipelago, 55 m, 1972 [USNM E51315 (1)]. Eastern Antarctica, off Wilkes Land, 183–237 m, 1961 [USNM E51316 (3)]; off Enderby and MacRobertson Lands, Prydz Bay, 65°56′–67°41′S, 50°52′–77°32′E, 98–400 m [ANARE, NMV F68044 (1), F68047 (2), F68084 (1), F68668 (1), F72614 (1), F84985 (1)].

Type locality. Western Antarctica, Scotia Sea.

Distribution. Western Antarctica, Weddell Sea, 125–990 m (Gutt, 1991b, as *P. navicula*); Scotia Sea, 165–183 m (Vaney, 1908); off Coats Land, South Shetland Is, South Sandwich Is, Palmer Archipelago, 55–613 m (this paper). Southern Ocean, east of Bouvet I., 567 m (Ludwig and Heding, 1935, as *P. bistriatum*). Eastern Antarctica, off Terre Adélie, 10–170 m (Cherbonnier, 1974); off Wilhelm II Land, 350–385 m (Ekman, 1927, as *P. navicula*); Prydz Bay, 98–400 m (this paper).

Remarks. Based on the original descriptions, and examination of *P. coatsi* specimens, *Psolidium navicula* Ekman, 1927 and *Psolidium bistriatum* Ludwig and Heding, 1935 are considered here to be junior synonyms of *Psolicrux coatsi* (Vaney, 1908). A distinctive diagnostic character is the consistent occurrence of the small, irregular, bluntly spinous crosses illustrated by Vaney (1908) for *P. coatsi*, by Ekman (1927) for *P. navicula*, by Ludwig and Heding (1935) for *P. bistriatum*, and referred to as "cups" by Panning (1949) [they are not cupped]. The three authors illustrated short spinous apophyses rising from the end of smooth perforated oval to elongate plates, and observed that the mid-body ventral radial tube feet were larger than those extending to the introvert and anus and referred their species to *Psolidium*. All recognised the posterior tapered conical body form. Ekman (1927) and Ludwig and Heding (1935) illustrated the distinctive constricted base of the anterior projections of the radial plates of the calcareous ring. Ludwig and Heding (1935) considered that the plates with a narrow perforated spinous end and the knobbed crosses were similar to the ossicles of *Cucumaria insolens* Théel, 1886 from South Africa, but in the illustrations by Théel (1886a) the plates in *C. insolens* are knobbed, not smooth, and the spinous end is not angled above the plate. The knobbed crosses in *C. insolens* are cupped.

Cucumaria conspicua Vaney, 1908 was described from a single small specimen (10 mm long) taken at the same station as *P. coatsi*. It had a thin flat oval ventrum with large radial tube feet, small tube feet scattered beyond the dorsolateral radial series, terminal mouth and anus, short posterior taper, and single-layered perforated plate ossicles with spinous taper. This specimen is considered here to be a juvenile *P. coatsi*.

Ekman (1925) described material as *Cucumaria coatsi* which had anterior interradial brood pouches, ten tentacles with the two ventral ones smaller, and ossicles not consistent with those of *P. coatsi*, which does not have brood pouches, has ten subequal tentacles, and has small spinous crosses and elongate perforated plate ossicles with raised narrow short perforated spinous ends. The material described by Ekman (1925) was not *P. coatsi*. Ossicles of *P. coatsi* illustrated by Massin (1994) are similar to those of Ekman (1925), and do not resemble those illustrated by Vaney (1908) for the type of *P. coatsi*. The distribution of *P. coatsi* is extended here to eastern Antarctica.

Staurocucumis liouvillei (Vaney)

Cucumaria liouvillei Vaney, 1914: 12–14, pl. 3 figs 1–3.—Ekman, 1925: 85–89, fig. 18.

Staurocucumis liouvillei.—Ekman, 1927: 363, 374–381, figs 7, 8.—Heding, 1942: 33.—Panning, 1949: 455.—Cherbonnier, 1974: 609.—Hansen, 1988: 301–302, 304, 307, fig. 3.—Massin, 1994: 129–132, fig. 1.—O'Loughlin et al., 1994: 552, 554.

Cucumaria mira Ludwig and Heding, 1935: 172–179, figs 39–41.

Trachythyone mira.—Panning, 1949: 426.—O'Loughlin et al., 1994: 552, 554 [new synonymy].

Abyssocucumis liouvillei.—Gutt, 1991b: 324.

Material examined. Eastern Antarctica, off Kemp Land, 66°45′S, 62°03′E, 177 m, 1931 [BANZARE Stn 107, SAM K1848 (4 specimens)]; Prydz Bay, 66°53′–68°58′S, 68°56′–77°33′E, 131–791 m [ANARE, NMV F68018 (1), F68022 (1), F68025–68027 (12), F68029 (5), F68031–68034 (27), F68036 (1), F68038 (1), F68040 (2), F68048 (1), F68055 (1), F68059 (1), F68061–68062 (2), F68064 (1), F68077–68078 (2), F68080–68081 (4), F68086 (1), F68089 (1), F68096 (2), F68099 (1), F68656 (1), F69101 (2), F69103 (4), F69129 (1), F69133 (2), F71991 (1)]. Heard I., 51°17′–53°13′S, 71°45′–76°32′E, 60–541 m [ANARE, NMV F85015–85034 (105)].

Type locality. Western Antarctica, Bellingshausen Sea side of Antarctic Peninsula.

Distribution. Western Antarctica, west of Antarctic Peninsula, 98–297 m (Vaney, 1914); South Georgia, 125–310 m (Ekman, 1925); Weddell Sea, 160–745 m (Gutt, 1991b). Southern Ocean, east of Bouvet I., 439–567 m (Ludwig

and Heding, 1935, as *C. mira*). Eastern Antarctica, off Terre Adélie, 385 m (Cherbonnier, 1974); off Wilhelm II Land, 350–485 m (Ekman, 1927); Prydz Bay, 131–791 m (this paper). Kerguelen region, Heard I., 60–541 m (this paper).

Remarks. The Antarctic and Heard I. specimens were indistinguishable in terms of: size (up to 80 mm long); thin body wall with outer gelatinous brown layer, darkens with age; ten equal long very branched tentacles, always extended, frequently lost; tube feet on radii only, more developed ventrally; calcareous ring normally not evident; ossicles frequently not evident in larger specimens; oval bowl ossicles with denticulate perforations. Vaney (1914) illustrated a bowl 0.22 mm long for type material [size of specimen sampled not given]. For Bouvet material Ludwig and Heding (1935) illustrated a bowl 0.11 mm long for a 7.5 mm specimen. For western Antarctic material Massin (1994) illustrated bowls up to 0.13 mm long in a 10 mm long specimen, and 0.22 mm long in a 51 mm specimen. Eastern Antarctic material in this study had bowl sizes up to 0.29 mm long in a 65 mm long contracted specimen (NMV F68031). Bowl size increases significantly with increasing size of specimens. Eastern Antarctic and Heard bowl sizes differed significantly for specimens of similar size, the largest bowls up to 0.29 mm long in a 65 mm long contracted specimen (Antarctic, NMV F68031) and 0.17 mm long for a 70 mm long contracted specimen (Heard, NMV F85033). Based on the description and illustrations of *C. mira* Ludwig and Heding, 1935, it is considered here to be conspecific with *S. lionvillei*. The distribution of *S. lionvillei* is extended here to the Kerguelen region.

Trachythyone lechleri (Lampert)

Thyone (Thyonidium) lechleri Lampert, 1885: 253, pl. 1 fig. 64.—Théel, 1886a: 267.

Thyone lechleri.—Ludwig, 1898a: 44–49, pl. 2 figs 26–30, pl. 3 figs 31–33.—Perrier, 1905: 35–38.—Ekman, 1925: 101–103, fig. 22.—Deichmann, 1947: 335–336.

Thyone hassleri Théel, 1886b: 11–12.

Trachythyone lechleri.—Panning, 1949: 426, figs 12–14.—Panning, 1964: 166–167, figs 6, 7.—Pawson, 1964: 459–461, fig. 2(1–5).—Hernandez, 1982: 256–257; figs 1b, 3b, 4; pl. 2j–m.

Material examined. Kerguelen I., Royal Sound, 49°28′S, 70°12′E, 47 m, 1930 [BANZARE Stn 59, SAM K1849 (1 specimen)]; Heard I., 52°32′–53°30′S, 73°10′–73°41′E, 60–238 m [ANARE, NMV F84992–84995 (6)].

Type locality. Straits of Magellan.

Distribution. Magellanic region, Straits of Magellan, Tierra del Fuego, up to 30 m (summary by Pawson, 1964). Kerguelen region, Kerguelen and Heard Is, 47–238 m (Pawson, 1964; this paper).

Remarks. The Heard I. material does not differ in any recognisable way from the descriptions and illustrations of Magellanic region material by Ludwig (1898a), Ekman (1925) and Pawson (1964). The largest specimen is 145 mm long (Pawson gave 150 mm), and the multiple series of radial tube feet create a superficial appearance of covering the whole body. The distinctive irregularly oval plates, with sparse to absent small perforations, are typically 0.16 and up to 0.28 mm long (Ekman gave 0.12 mm, Pawson 0.2 mm). The large perforated plates, present in small specimens only, are up to 0.38 mm long (Ludwig gave 0.43 mm, Ekman 0.21 mm). The thick cupped spinous crosses are 0.05–0.06 mm long (Pawson gave 0.05 mm).

The type material for *T. hassleri* was taken in the Straits of Magellan, and Théel (1886b) acknowledged the strong resemblance to *T. lechleri*. Ludwig (1898a) synonymised the two species, and Pawson (1964) commented in detail on the synonymy and agreed. Pawson (1964) identified a single specimen from Heard I. in the Dominion Museum (Wellington, New Zealand) as *T. lechleri*, and additional material is present in the BANZARE collection from Kerguelen and ANARE collections from Heard I. This species has not been reported for Antarctica, but occurs in the Magellanic region and at greater depth in the Kerguelen region.

Paracucumidae Pawson and Fell

Paracucumis turricata (Vaney) comb. nov.

Thyone turricata Vaney, 1906a: 401–402, fig. 3.—Ekman, 1925: 108–111, fig. 25.

Paracucumis antarctica Mortensen, 1925: 9–12, figs 6–8.—Panning, 1936: 11–14, figs 1–5.—Heding and Panning, 1954: 46–47, fig. 7.—Pawson, 1982: 815.—O'Loughlin et al., 1994: 552, 554 [new synonymy].

Paracucumis turricata.—Panning, 1936: 14.

Ypsilocucumis turricata.—Panning, 1949: 455.—Cherbonnier, 1974: 610.—Gutt, 1991b: 324.

Material examined. Thyone turricata, Vaney, 1906. Holotype (MNHN). Western Antarctica, South Orkney Is, Scotia Bay, littoral, 1905.

Other material. Eastern Antarctica, off Wilkes Land, 65°10′S, 108°12′E, 474 m, 1931 [BANZARE Stn 97, SAM K1846 (1 specimen)]; Prydz Bay and Mac-Robertson Shelf, 66°54′–68°57′S, 63°06′–76°38′E,

367–1240 m [ANARE, NMV F68101 (1), F68151 (5), F68671–68674 (5), F69122–69123 (48), F69128 (2), F69132 (29), F71983–71984 (9), F71986 (1), F81430 (1), F91298 (3)].

Distribution. Western Antarctica, Weddell Sea, 620–705 m (Gutt, 1991b); off Graham Land, 125 m (Ekman, 1925); South Orkney Is (Vaney, 1906a). Eastern Antarctica, Ross Sea, Discovery Inlet, 550–560 m (Mortensen, 1925, as *P. antarctica*); off Terre Adélie, 10–15 m (Cherbonnier, 1974, as *Y. turricata*); off Wilkes Land, Prydz Bay, MacRobertson Shelf, 367–1240 m (this paper).

Remarks. The illustrations of unique large plates with central digitate towers for *P. antarctica* by Mortensen (1925) and Heding and Panning (1954), and for *T. turricata* by Vaney (1906a) and Ekman (1925), show the same ossicle form, and illustrate the plates seen in this study of the type and BANZARE and ANARE material. *Paracucumis antarctica* Mortensen, 1925 is considered here to be a junior synonym of *Thyone turricata* Vaney, 1906a. This synonymy removes the anomaly of the previously reported mutually exclusive occurrences of *T. turricata* in Western Antarctica and off Terre Adélie, and of *P. antarctica* in the Ross Sea and Prydz Bay.

Ossicle form does not vary significantly with specimen size, but tentacle form and number (up to 15) are variable. The description by Vaney (1906a) of eight and two small tentacles on the small (12 mm long) type specimen of *T. turricata* does not apply to large specimens. ANARE specimens were up to 220 mm long (excluding tentacles). Two specimens (more than 200 mm long, NMV F91298) had 14 tentacles in combinations of ten large subequal with four adjacent small subequal, and 12 large with two adjacent small. Calcareous ring form is also variable, as noted and illustrated for *P. antarctica* by Mortensen (1925) and Heding and Panning (1954). One specimen (200 mm long, NMV F68101) had five radial plates deeply bifurcate anteriorly and five interradials with single narrow anterior projections, creating 15 anterior projections. Mortensen (1925) noted for *P. antarctica* that ossicles were spaced in a thin transparent body wall in relaxed specimens, but imbricating in contracted specimens.

Panning (1936) recognised the close similarity of *T. turricata* to *P. antarctica*, and reassigned *T. turricata* to *Paracucumis*. Panning (1949) subsequently reassigned *T. turricata* to his new genus *Ypsilocucumis*. *T. turricata* has dendritic tentacles and belongs in the Dendrochirotida, not the Dactylochirotida with digitiform tentacles (Pawson and Fell, 1965), and cannot be retained in *Ypsilocucumis* Panning, 1949. It is reassigned here to *Paracucumis* Mortensen, 1925.

Order **Elasipodida** Théel

Elpidiidae Théel

Amperima robusta (Théel)

Scotoplanes robusta Théel, 1882: 35–36, pls 6, 34(6–7), 37(9).

Amperima robustum.—Agatep, 1967a: 56–57.

Amperima robusta.—Hansen, 1975: 161–162, figs 77–78.

Material examined. North-east of Kerguelen, 47°05′S, 79°16′E, 3112 m, 1930 [BANZARE Stn 66, SAM K1842 (2 specimens)].

Type locality. Southern Ocean, 53°55′S, 108°35′E, 3568 m.

Distribution. Antarctica, 2010–4240 m; Kermadec Trench, 2640 m (summary by Hansen, 1975); southern Indian Ocean, 3112 m (this paper).

Remarks. The two specimens were small (up to 14 mm long) and very damaged, but had the characteristics of the species as described by Hansen (1975). There were ten tentacles; the velum consisted of the two pairs of papillae with a pair of very small lateral ones; the small specimens had only nine pairs of tube feet, but they bordered the posterior two-thirds of the sole with the anterior pairs larger and more spaced and the posterior pairs decreasing in size; the ossicles were tripartite with distal spines and spinous apophyses on each arm. The ossicles were eroded, but two variations from the descriptions by Hansen (1975) were evident. Spinous apophyses were present on ventral tripartite ossicles which were up to 0.26 mm wide, and no C-shaped ossicles were found. These damaged specimens were similar to two species described by Gebruk (1988). On the limited evidence available, they differed from *Amperima belyaevi* Gebruk, 1988 [Aleutian Is, 5030 m] by having slightly larger ventral ossicles, larger ossicle spinelets, and less evenly spaced tube feet. They differed from *A. vitjazi* Gebruk, 1988 [off Chile, 4300 m; Japan Sea, 6096 m] by being significantly smaller, having unbranched ossicles, and unevenly spaced tube feet.

Rhipidothuria racovitzai Hérouard

Rhipidothuria racovitzai Hérouard, 1901: 41–42.—Hérouard , 1906: 7–8, pl. 1 figs1–3.—Hansen, 1975: 131.—Gebruk, 1990: 81, fig. 28 (3–4).—Gebruk and Shirshov, 1994: 148–149, fig. 1.

Achlyonice violaecuspidata Gutt, 1990: 123–125, figs 7–10.—Gutt, 1991b: 324.

Material examined. Achlyonice violaecuspidata, Gutt, 1990. Paratypes. Western Antarctica, Weddell Sea, 77°08′S, 48°36′W, 235 m, 1984 [ZIM E-7144 (2 specimens)].

Other material. Eastern Antarctica, off Enderby Land, 66°10′S, 49°41′E, 300 m, 1930 [BANZARE Stn 39, SAM K1829 (1)]; 66°12′S, 49°37′E, 300 m, 1930 [BANZARE Stn 40, SAM K1830 (24)]; off Wilkes Land, 65°10′S, 108°12′E, 474 m, 1931 [BANZARE Stn 97, SAM K1831 (3)].

Type locality. Western Antarctica, Bellingshausen Sea.

Distribution. Western Antarctica, Weddell Sea, 225–785 m (Gutt, 1991b, as *Achlyonice violaecuspidata*); Bellingshausen Sea, 800 m (Hérouard, 1901; depth estimated from latitude and longitude). Eastern Antarctica, off Enderby and Wilkes Lands, 300–474 m (this paper).

Remarks. The 28 BANZARE specimens fitted the diagnosis by Gebruk and Shirshov (1994), except that no crosses were found. Specimens were up to 60 mm long. There were ten tentacles, the anteriormost largest; seven pairs of dorsal papillae, distributed evenly along the dorsum; 12 pairs of tube feet, the posterior ones smallest and webbed; and a velum comprising two pairs of transverse papillae. Tentacles, mouth, papillae, tube feet and anus were a residual violet brown colour. Rod ossicles were found in the tentacles, tube feet and body wall. Rods were bent or straight or curved, unbranched, not perforated, sometimes thickened centrally, and sometimes with small knobs. Rod lengths were up to 0.46 mm (tentacles) and 0.37 mm (body wall). Hérouard (1901) noted that ossicles were probably in the form of a cross surmounted by a single point. Crosses were not found by Gutt (1990), Gebruk and Shirshov (1994), and this author. "Crosses" were observed in the BANZARE material, but were sponge spicules. This species is not represented in the extensive ANARE collections from eastern Antarctica, but the BANZARE specimens do extend the distribution of this species to eastern Antarctica.

Laetmogonidae Ekman

Laetmogone wyvillethomsoni Théel

Laetmogone wyvillethomsoni Théel, 1879: 10, pl. 1 figs 12–13.—Théel, 1882: 73–78, pls 11, 12, 31(14–16), 34(1), 36(3), 37(5, 7, 11), 38(9), 39(4), 42(1, 7), 43(4), 44(14), 46(2–3).—Agatep, 1967b: 63, pls 8(1–11), 9(1–10); tbl. 1.—Hansen, 1975: 54–57, fig. 20, tbls 5–8.—Gutt, 1991b: 324.—Gebruk, 1993: 240, fig. 6 (1).

Laetmogone cf. *wyvillethomsoni*.—O'Loughlin et al., 1994: 553–554.

Material examined. Syntype. Pacific Ocean, 33°42′S, 78°18′W, 2514 m, *Challenger* Stn 300 [BMNH 83.6.1.8.45 (1 specimen)].

Other material. Eastern Antarctica, off MacRobertson Land, 66°48′S, 71°24′E, 540 m, 1929 [BANZARE Stn 30, SAM K1827 (1)]; off Kemp Land, 66°21′S, 58°50′E, 603 m, 1930 [BANZARE Stn 34, SAM K1828 (1)]; Prydz Bay, 67°10′–68°32′S, 71°18′–73°14′E, 515–743 m [ANARE, NMV F68168 (1), F76585 (1), F76605 (1), F81826–81828 (22)].

Type locality. Southern Pacific Ocean, off Chile.

Distribution. Southern Ocean, Kermadec Trench, 2514–4410 m (Hansen, 1975); Scotia Sea, South Shetland Is, 2672–4136 m (Agatep, 1967b). Western Antarctica, Weddell Sea, 245–1130 m (Gutt, 1991b). Eastern Antarctica, off Kemp Land, Prydz Bay, 515–743 m (this paper).

Remarks. One well-preserved specimen (NMV F81825) was 55 mm long and had 14 tentacles, 20 pairs of tube feet, 14 pairs of thin papillae some as long as the body, large terminally spinous ventral rods up to 0.4 mm long, an overall body range of wheel sizes from 0.04 to 0.21 mm diameter with 8–16 outer spokes and 4–6 inner rays, and showed no significant variations from the type examined and the observations by Hansen (1975). Hansen (1975) gave wheel diameters up to 0.17 mm, Théel (1879) up to 0.16 mm. Two eastern Antarctic specimens (NMV F81826), 80 and 140 mm long, had wheel diameters up to 0.19 and 0.18 mm respectively. Wheel size does not vary with increase in specimen size. In the Southern Ocean and the Kermadec Trench this species is abyssal, but around the Antarctic continent it occurs at bathyal depths.

New distributions summary

Four holothurian species are confirmed here as occurring in both the Magellanic and Kerguelen regions: *Chiridota pisanii* Ludwig, 1886, *Taeniogyrus contortus* (Ludwig, 1875), *Heterocucumis godeffroyi* (Semper, 1868) and *Trachythyone lechleri* (Lampert, 1885). Only *T. contortus* occurs also on the Antarctic coast. *Staurocucumis liouvillei* (Vaney, 1914) occurs in Antarctica and off Heard I., but not in the Magellanic region. All of the holothurians reported here with an Antarctic distribution occur in both western and eastern Antarctica, with *Meseres spiculiferus* sp. nov. an unconfirmed exception. Significant new distribution data are tabulated in Table 4.

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A NEW SPECIES OF *NEANTHES* (POLYCHAETA: NEREIDIDAE) FROM SOUTHERN AUSTRALIA

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Abstract

Bakken, T., 2002. A new species of *Neanthes* (Polychaeta: Nereididae) from southern Australia. *Memoirs of Museum Victoria* 59(2): 327–331.

A new species of *Neanthes* from southern Australia is described. Examination of several species of *Neanthes* has resulted in a re-interpretation and stronger emphasis of parapodial characters than is usual in descriptions of nereidid species. These characters are used to describe *Neanthes tasmani* sp. nov. and to distinguishing the new species from the closely related *Neanthes bassi* Wilson, 1984.

Introduction

In an earlier study of *Neanthes* from Victoria, Wilson (1984) found four specimens closely allied to *Neanthes bassi* Wilson, 1984 that possessed characters indicating they belonged to a different species. Re-examination of these four specimens and additional material, as well as more material of *N. bassi*, confirms that this material belongs to a new species.

This study has also resulted in a re-evaluation of parapodial characters used to describe nereidids. The use of detailed descriptions of morphology of parapodia in nereidids was presented by Hylleberg et al. (1986) and Hylleberg and Nateewathana (1988). The importance of these characters is evident in several apparently closely related species of *Neanthes* from southern Australian waters. Parapodial characters tend to vary with specimen size. Wilson (1984) showed that parapodial ligules and lobes tend to occur over a smaller range of chaetigers in specimens with body width less than 1.5 mm than in larger specimens. Parapodial ligules and lobes may be missing altogether in specimens with body width less than 1 mm, especially pre- and postchaetal lobes.

In the present study a distinction is made between a prechaetal or postchaetal lobe and an acicular process. These features are used in the present description to distinguish *N. tasmani* sp. nov. from closely related taxa. My own examination of several nereidine taxa has proved these features to be important characters over a wide range of taxa within the subfamily. In the notopodium a prechaetal lobe is clearly present as a lobe (Fig. 1B) but might be of any size from a small lobe barely evident beyond the dorsal collar to a lobe as long as the dorsal and ventral ligules. An acicular process on the other hand is fused to the ventral notopodial ligule as a ridge on the ligule itself (Fig. 1D). In the neuropodium a clearly identifiable postchaetal lobe is found in many species. This lobe might be digitiform or flattened, a distinction that should be explicit in descriptions. The postchaetal lobe may be reduced in posterior chaetigers, present throughout the body or be absent. If the lobe is absent an acicular process might be present instead, most often seen as an oval process protruding beyond the tip of the aciculum. Pre- and postchaetal lobes and acicular processes can be seen in figures in earlier studies (e.g. Hutchings and Turvey, 1982; Wilson, 1984), but it is important that they are clearly outlined in species descriptions so that otherwise similar species can be distinguished using these characters. To give parapodial characters a stronger emphasise an end-view of parapodia are drawn for *N. tasmani* following the example of Hylleberg and Nateewathana (1986).

The material presented in this work is deposited in Museum Victoria, Melbourne (NMV), Australian Museum, Sydney (AM) and the South Australian Museum, Adelaide (SAM). Measurements of body width are measured without parapodia at about chaetiger 10. This is consistent with earlier studies (e.g. Wilson, 1984) and will be used in future studies as a standard measurement.

Neanthes Kinberg, 1866

Type species. Neanthes vaalii Kinberg, 1866.

Diagnosis. Eversible pharynx with conical paragnaths on both rings, bar-shaped paragnaths in Area IV may be present. Four pairs of tentacular cirri. Parapodia biramous. Notochaetae homogomph spinigers; neurochaetae including homogomph and heterogomph spinigers (after Wilson, 1988).

Neanthes bassi Wilson

Neanthes bassi Wilson, 1984: 210–212, fig. 1.

Material examined. Holotype, NMV F50005. Paratypes, NMV F50006—F50011 (fully location data given in Wilson, 1984).

Additional material. Victoria. NMV F50012–F50017; NMV F50123 (2 specimens); NMV F41866 (referred to as G1866 with full data in Wilson, 1984).

Tasmania. Coles Bay, near boatramp (42°7.0'S 148°17.0'E), 0.5 m, *Zostera* sediment, airlift, 21 Apr 1985, R.S. Wilson (stn TAS 18), NMV F88282.

South Australia. Upper Spencer Gulf (33°16'S 137°51'E), 16 km SW of First Creek, subtidal sand, 12.1 m, T.J. Ward and P.C. Young (stn 795 CG/7), AM W21787; Spencer Gulf, Sir Joseph Banks, Group Reevesby Is, Home Bay South, seagrass bed, upper subtidal, 22 Jan 1986, S.A. Parker, SAM T.E5831 (32 specimens); Pt Lincoln, SAM T.E5859 (1 specimen, epitoke).

Western Australia. Stuart Head, Yacht Club, Princess Royal Harbour (35°04'S, 117°55' E), *Posidonia australis*, 1 m, handheld corer on SCUBA, P. Hutchings, Jan 1988 (site 7), AM W26811; Bramble Point, Princess Royal Harbour (35°02'S, 117°55'E), *Posidonia sinuosa*, 2.5 m, handheld corer on SCUBA, P. Hutchings, Jan 1988 (site 11), AM W26812.

Description. Size range of material examined from 3 mm long, 15 chaetigers and less than 1 mm wide to 22 mm, 70 chaetigers, 1.5 mm wide (complete specimens); from 10 mm, 20 chaetigers, 2 mm wide to 38 mm, 58 chaetigers, 4 mm wide (anterior fragments). Pharynx with conical paragnaths and bars in Area IV, paragnath counts for 29 specimens includes: I = 0–4; II = 6–27; III = 1–14; IV = 1–18, in addition 2–7 bars on each side; V = 0–1; VI = 2–16, usually less than 10; VII–VIII = 5–30. Glandular patches in notopodia present from midbody chaetigers. Prechaetal notopodial lobe (as described by Wilson, 1984) absent but notopodial acicular process present in chaetigers 5–25.

Habitat. Some of the material reported here was collected in the intertidal and upper subtidal, extending the depth-range for this species from intertidal to 51 m. The shallower records are from seagrass-beds including *Posidonia* and *Zostera*.

Distribution. Neanthes bassi is recorded for the first time in Western Australia at Albany and in South Australia from Spencer Gulf. This species is only known from southern Australia, Albany, WA, to off Lakes Entrance, Vic., including north and east coasts of Tasmania.

Remarks. The material examined agrees well with the original description, although parapodial characters are reinterpreted. Numbers of paragnaths are extended for some Areas. Dorsal pigment spots described from the material in the original description are absent in some specimens from Spencer Gulf (SAM T.E5831), and tend to vary in prominence in other specimens.

Neanthes tasmani sp. nov.

Figure 1

Neanthes cf. *bassi* Wilson, 1984: 212.

Material examined. Holotype. Eastern Bass Strait, 100 km off North Point, Flinders I., (31°51.8'S, 148°26.5'E), 130 m, fine sand, Smith-MacIntyre grab, R. Wilson, 15 Nov 1981, RV *Tangaroa* (stn BSS 170-G), NMV F50018.

Paratypes. Eastern Bass Strait, 100 km off North Point, Flinders I. (31°52.6'S, 148°25.2'E), 140 m, WHOI epibenthic sled, R. Wilson, 15 Nov 1981, RV Tangaroa (stn BSS 170-S), NMV F50019–F50021 (3 specimens). Tasmania, E of Maria I. (42°36.0'S, 148°10.0'E), 75 m, fine bryozoa and shell, WHOI epibenthic sled, R.S. Wilson, 23 Apr 1985 (stn TAS 30), AM W27491 (2 specimens).

Description. Holotype, complete specimen 9 mm long for 44 chaetigers, 1.5 mm wide. Body robust, flattened, tapering posteriorly. Colour in alcohol creamy yellow. Prostomium slightly wider than long. Two pairs of dark red to black eyes. One pair of antennae 1.5 times longer than palps. Palps stout with conical palpostyles, wider than long. Four pairs of tentacular cirri, faintly annulated, longest (posterodorsal) pair reaching to chaetiger 9. The first (apodous) segment broadened, enclosing the posterior part of prostomium. Pharynx with translucent yellow to light brown jaws with 7 teeth. Conical paragnaths present on both rings and short bars also present in Area IV, arranged as follows: I = 3 in a longitudinal row; II = 18 (left), 20 (right), 2 rows in an arc; III = 5 in a diamond-shaped group; IV = 15 (left), 7 (right), bars missing on left side, 4 bars on right side; V = 0; VI = 3 (left), 3 (right), in one row; VII–VIII = 8, in single row.

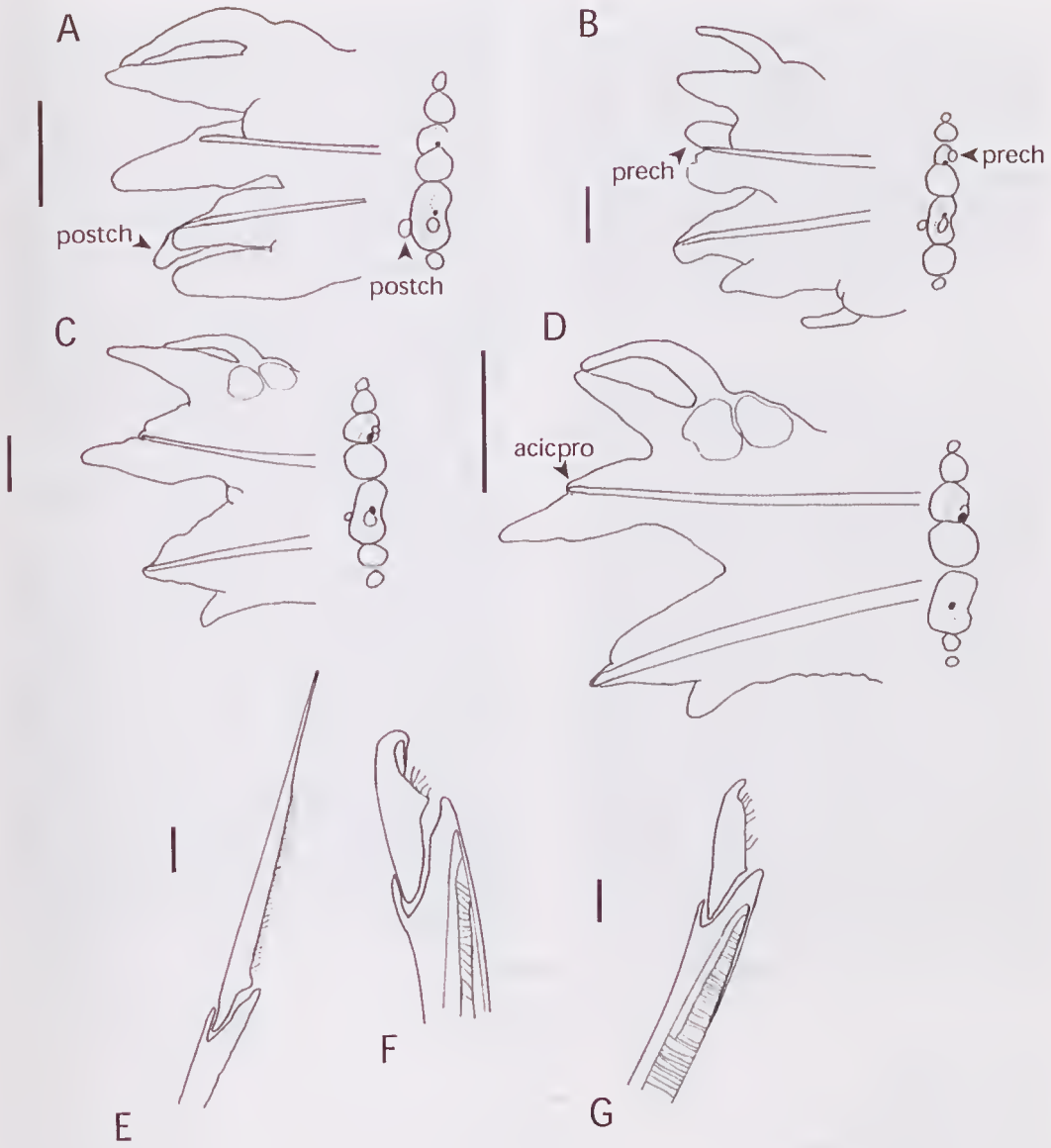

Figure 1. *Neanthes tasmani* sp. nov. Holotype, NMV F50018: a, anterior view of chaetiger 3; b, anterior view of chaetiger 10; c, anterior view of chaetiger 21; d, anterior view of chaetiger 30; g, heterogomph falciger from chaetiger 10.

Paratype, AM W27491: e, heterogomph spiniger with short blade from chaetiger 3; f, heterogomph falciger from chaetiger 30.

Abbreviations: postch = postchaetal lobe, prech = prechaetal lobe, acicpro = acicular process. Scale bars A–D, 0.1 mm; E–G, 0.01 mm. Drawings of the end-view of parapodia are not to scale. End-views are drawn with the anterior end of the specimens to the right.

Dorsal cirrus slightly shorter than ventral notopodial ligule in anterior chaetigers, becoming longer posteriorly up to 1.5 times longer in the few posteriormost chaetigers, basally attached throughout. Dorsal notopodial ligule conical, rounded anteriorly becoming pointed posteriorly; not more than 1.5 times as long as ventral ligule anteriorly, becoming smaller than ventral ligule in posterior chaetigers (Fig. 1D). Ventral ligule conical anteriorly slender and pointed in midbody and posterior chaetigers. Distinct digitiform prechaetal lobe present in chaetigers 5–15 (Fig. 1B). Glandular patches in mid-body and posterior chaetigers.

Neuropodia with prominent inferior lobe in anterior and midbody chaetigers, reduced posteriorly. A distinct digitiform postchaetal lobe present in chaetigers 1–22 (Figs 1A–C). Ventral neuropodial ligule conical, rounded, as long as acicular ligule in anterior chaetigers, smaller, pointed and reduced in posterior chaetigers. Ventral cirri approximately 0.5 times as long as neuropodial acicular ligule, basally attached throughout.

Notochaetae homogomph spinigers, in single straight row between dorsal and ventral ligules. Neurochaetae dorsal fascicle homogomph spinigers and heterogomph falcigers, falcigers with long blades in anterior chaetigers, with short blades in posterior ones (from approximately chaetiger 10). Ventral fascicle heterogomph spinigers with both short and long blades in anterior chaetigers (Fig. 1E), including falcigers (Fig. 1G) from approximately chaetiger 10, in posterior chaetigers heterogomph spinigers (long blades) and heterogomph falcigers (Fig. 1F). Paired cirriform pygidial cirri reaching back 6 chaetigers.

Variation. Variations of 5 paratypes, size range 3 mm long for 14 chaetigers, less than 1 mm wide to 12 mm long for 30 chaetigers, 2 mm wide (anterior fragments), one complete specimen (NMV F88283) 9 mm long for 41 chaetigers, 1 mm wide. Eyes black in paratypes (NMV F88283). Paragnath counts for 5 specimens as follows: I = 2–4; II = 10–25; III = 3–13, in transversal rows; IV = 8–23, also short bars 0-3 on either side; V = 0; VI = 2–8, in circular groups; VII–VIII = 4–7 in a single row. Paragnaths often pale and flattened with large base, including short bars present in Area IV. These might de difficult to distinguish from cones, as the cones are sometimes placed closely together.

Notopodial prechaetal lobe present from chaetiger 5–15. Neuropodial postchaetal lobe present from chaetiger 1 to 18–20.

Remarks. Neanthes tasmani closely resembles *N. bassi* but can be distinguished by the absence of a prechaetal notopodial lobe. Other distinguishing characteristics are given in Table 1. *Neanthes tasmani* also resembles *N. flindersi* Wilson, 1984 as this species has notopodial prechaetal lobes and neuropodial postcheatal lobes in the same range as *N. tasmani*. The two species can be distinguished by length of dorsal parapodial cirri which in *N. flindersi* is 1.5–2.5 times the dorsal notopodial ligule, and by the absence of bars in Area IV in the latter species. *Neanthes kerguelensis* McIntosh, 1885 and *N. nanhaiensis* Wu, Sun and Yang, 1985 both have

Table 1. Comparison of *Neanthes bassi* and *N. tasmani*.

	Neanthes tasmani	*Neanthes bassi*
Area I paragnaths	2–4	0–4
Area II paragnaths	10–25	5–27
Area III paragnaths	3–13	1–14
Area IV (bars) paragnaths	7–23 (0–4)	1–18 (2–7)
Area V paragnaths	0	0–1
Area VI paragnaths	2–8	2–16
Area VII–VIII paragnaths	4–8	5–30
Length of dorsal cirri (times length of dorsal notopodial ligule)	<1–1.5	1
Notopodial dorsal ligule	reduced in posterior chaetigers	as long as notopodial ventral ligule throughout
Notopodial prechatal lobe	present, in chaetigers 3–15	absent, acicular process in chaetigers 5–25
Neuropodial postchaetal lobe	present, in chaetigers 1–21	present, in chaetigers 1–12
Habitat	fine biogenic sand, 75–140 m	sand, shell and mud, seagrass beds, intertidal to 51 m

notopodial prechaetal and neuropodial postchaetal lobes but can be distinguished from *N. tasmani* by the distribution of paragnath numbers and the length and form of the dorsal cirri and dorsal notopodial ligule (Wu et al., 1985; Wilson, 1984).

The reduced size of the dorsal notopodial ligule in the posteriormost chaetigers in *N. tasmani* (observed in the two complete specimens only) is also found in *N. isolata* Hutchings and Turvey, 1982 and *N. uniseriata* Hutchings and Turvey, 1982, but these species can be distinguished from *N. tasmani* by the absence of notopodial prechaetal and neuropodial postchaetal lobes, and by the number of paragnaths (Hutchings and Turvey, 1982; Wilson, 1984).

The faint short bars found in Area IV in *N. tasmani* are different from those present in *N. bassi*, which are very distinct and well developed, even in small specimens with body width less than 1 mm. In contrast, even in the largest specimens of *N. tasmani* the bars are faint and poorly developed, although clearly present. More material is needed to judge if there are further differences between the two species in this respect.

N. tasmani has a deeper depth range than the closely related *N. bassi*. Specimens were found from 75 m to 140 m, while *N. bassi* has a depth range from intertidal to 51 m.

Etymology. The species is named after Abel Tasman who was among the first Europeans to explore the southern seas of Australia and to set foot on Tasmania.

Distribution. Eastern Tasmania (east of Maria Island) and eastern Bass Strait; 75–140 m, fine biogenic sand.

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Memoirs of the Museum of Victoria 59(2): 333–336 (2002)

CORYSTOLONA, A NEW HYDROID GENUS (LEPTOLIDA: LEPTOTHECATAE) FROM SOUTHERN AUSTRALIA

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Abstract

Watson, J.E., 2002. *Corystolona*, a new hydroid genus (Leptolida: Leptothecatae) from southern Australia. *Memoirs of Museum Victoria* 59(2): 333–336.

A hydroid first described as *Reticularia annulata* Watson, 1973 from the Great Australian Bight is the type species of a new genus *Corystolona* in the family Clavidae, subfamily Corydendriinae Calder, 1988. The simple, stolonal colonies of *Corystolona* lack nematophores and have internal gonophores.

Introduction

Abundant colonies of a hydroid previously described as *Reticularia annulata* Watson, 1973 were collected in a survey of the Port of Launceston, Tasmania, Australia, in May, 2001. The colonies were found on wharf pilings at depths of 1–4 m below low water mark. The hydroid assemblage on the piles included the common southern Australian species, *Pennaria wilsoni* Bale, 1913, *Bimeria australis* Blackburn, 1937 and *Aglaophenia plumosa* Bale, 1882. The finding of several colonies with intact, extended hydranths and gonophores enclosed within the hydrocaulus showed *R. annulata* to be referrable to the family Clavidae McCrady, 1859 and to belong, with slight emendation, to the subfamily Corydendriinae Calder, 1988. Type and other material is held in the Museum of Victoria, Melbourne, Australia (NMV).

Clavidae McCrady, 1859

Corydendriinae Calder, 1988

Diagnosis (emended). Clavid hydroids with stolonal or erect colonies; branches of erect colonies adnate to hydrocaulus for a varying distance basally. Hydranths elongate, more or less cylindrical, not polymorphic; tentacles filiform, scattered over much of hydranth. Nematophores absent. Gonophores fixed, external or internal sporosacs or free medusae, arising from hydrorhiza, hydrocaulus, branches or pedicels but not from body of hydranths.

Remarks. Calder (1988) discussed the status of the family Clavidae, considering it to be sufficiently disparate to warrant separation into several subfamilies additional to the nominal subfamily Clavinae McCrady, 1859 and proposed the subfamily Corydendriinae Calder, 1988. With one difference the present specimens accord with the diagnosis of the Corydendriinae, this being that it is not clearly stated whether gonophores may be external or internal. The diagnosis of the Corydendriinae is therefore emended to accommodate both external and internal gonophores.

Corystolona gen. nov.

Diagnosis. Clavid hydroids with stolonal colonies, hydrocaulus simple, unbranched, perisarc firm, terminating at hydranth base; hydranths elongate, tubular, hypostome dome-shaped, tentacles filiform, scattered over hydranth body; gonophores fixed sporosacs, arising as blind sacs beside hydranths within perisarc of hydrocaulus.

Type species. Reticularia annulata Watson, 1973.

Etymology. Refers to relationship with the Corydendriidae and strictly stolonal habit of the colonies.

Remarks. Corystolona is close to a group of four clavid genera: *Corydendrium* van Beneden, 1844; *Tubiclava* Allman, 1864; *Rhizodendrium* Calder, 1988; and *Merona* Norman, 1865. These genera were rejected from consideration for *Corystolona annulata* because the gonophores of *Tubiclava* are borne on the hydranth body, those of *Rhizodendrium* and *Merona* are hydrorhizal, and *Corydendrium* as defined by van Beneden (1844), Millard (1975) and Bouillon (1985) includes only

those species with erect, ramified colonies, with either internal or external gonophores. The strictly stolonal colonies together with internal gonophores sets *Corystolona* apart from these genera. *Corydendrium brevicaulis* Hirohito, 1988 from Japan is a sparsely branched species with internal gonophores which should be included in the Corydendriinae. While *C. brevicaulis* is close to *Corystolona*, the strictly simple, stolonal hydrocauli of *Corystolona* distinguishes it from Hirohito's species.

Corystolona annulata (Watson, 1973)

Figure 1a–e

Reticularia annulata Watson, 1973: 164, figs 5, 6.

Material examined. Holotype, NMV G1922, microslide, NMV G2091, preserved material, remainder of holotype colony, Pearson Island, South Australia, 17 m, on calcareous bryozoan. NMV F91279 (malinol mounted microslide, infertile colony), NMV F91280 (malinol mounted microslide, female colony), NMV F91281 (malinol mounted microslide, male colony), NMV F91282 (alcohol preserved material). Port of Launceston, Tasmania, colonies from bryozoans on wharf pilings 1–4 m, Aquenal Pty Ltd, May 2001.

Description (of Tasmanian material). Colonies comprising a few to many hydrocauli given off from poorly adherent tubular stolons; stolons unbranched or very sparsely branched, occasionally produced into a loose tangle where growing end becomes free of substrate; perisarc smooth to rather crumpled.

Single hydrocauli given off at various angles and at irregular intervals along stolon.

Perisarcal tube horn-shaped, proximally narrow at junction with stolon, but without true pedicel, thereafter widening to become cylindrical; length very variable, younger tubes often quite short and narrow, mature ones wider, straight or with 1 or 2 bends; sometimes recurved into a loop.

Perisarc of younger hydrocauli thin but firm, becoming thicker with age; perisarc evenly and deeply transversely annulated in basal third, corrugations usually continuing throughout length of tube, occasionally becoming smoother distally. Margin circular, perisarc of rim usually thinner and more fragile than rest of tube, sometimes torn by eruption of hydranth.

Hydranth long, cylindrical, with tall, narrowly dome-shaped hypostome with deep central slit; body with 26–30 scattered filiform tentacles, an incipient ring of 4–5 tentacles below hypostome; tentacles longest in mid-region, becoming shorter proximally; tentacles armed with prominent rings of nematocysts. Base of hydranth enclosed in a long funnel-shaped sheath of tissue inside tube; when hydranth retracted sheath becomes a muscular supporting girdle.

Colonies dioecious, gonophores laying beside hydranth deep within perisarcal tube; gonophore digitate with blunt distal end, no spadix, female containing 10–12 small ova, male of same shape as female but with undifferentiated spermatogenic mass.

Two kinds of nematocysts in hydranths: (1) desmonemes, capsule broadly droplet-shaped, 6.4–6.8 x 3.6–4.4 μm; and (2) euryteles, capsule elongate droplet-shaped, 8.4–10.4 x 4.0–4.8 μm, set in rings in tentacles. Both types of nematocysts very abundant; none found discharged.

Colour. Perisarc of younger hydrocauline tubes translucent white, darkening to horn-coloured with thickening of perisarc. Young stolons opaque white. Hydranth and tentacles (formol preserved) white, a trace of pink in some hydranths.

Measurements of mature specimens (μm):

Hydrorhiza	
Diameter of stolon	140–176
Hydrocaulus	
Length of mature tube	640–4,000
Proximal width	152–176
Diameter at margin (mature tube)	320–560
Hydranth	
Length extended (preserved material)	540–900

Remarks. The small sample of *Reticularia annulata* from Pearson I. in the eastern Great Australian Bight had deeply withdrawn, partly decomposed, sterile hydranths and disposition of the specimen on the bryozoan host was such that the bases of the hydrocauli were obscured; the specimen was thus mistakenly referred to *Reticularia* Thomson, 1853 (junior synonym, *Filellum*, Hincks, 1868). The smaller dimensions of the type compared with those of the present specimens is almost certainly due its being a young, infertile colony while the Tasmanian material ranges from young to aged. The difference in size of immature hydrocauli compared with older ones is a striking feature of the present material.

In 1839 d'Orbigny described *"Tubularia rugosa"* collected from a jetty south of the Rio Negro in Patagonia. He considered the specimen remarkable by its long annulated tubes but did not mention any soft parts. Bedot (1905) considered the material indeterminable but Leloup (1937) referred it to *Stephanoscyphus*. Notwithstanding

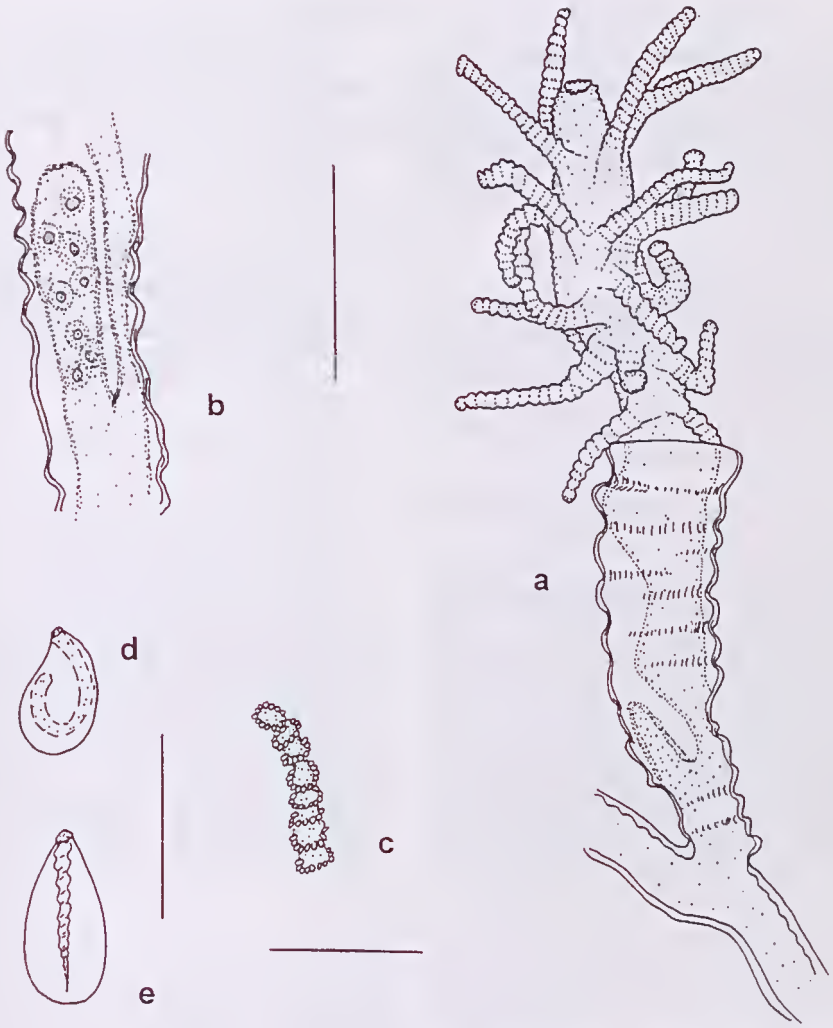

Figure 1. a, hydrorhiza, hydrocaulus and hydranth with young male gonophore. b, mature female gonophore with ova. c, rings of nematocysts in tentacle. d, desmoneme, undischarged. e, euytele, undischarged, from tentacles. Scale bar: a, b, 0.5 mm; c, 0.2 mm; d, e, 10 mm.

the opinion of these authors the similarities between d'Orbigny's specimen and *Corystolona annulata* suggests that it may be the same or similar species. As the type material of *T. rugosa* appears to be lost the question cannot be settled until the finding of live material.

Little information could be gleaned about substrate preferences of *Corystolona annulata* from the present samples since most colonies had been detached from their substrate in the laboratory. However, like the Pearson I. specimens several colonies were attached to a bryozoan, in this case, *Amathia* sp. Because of their poor adherence long strands of stolons could be easily freed from the substrate. The tightly contracted tentacles with many rings of nematocysts suggest that the tentacles are probably very extensible in life. The deeply slit hypostome indicates a capacity for wide expansion to engulf quite large prey. Because of retraction during preservation it could not be unequivocally established whether the mature hydranth is fully retractable into the tube, but the strong muscular band below the hydranth suggests that it is capable of doing so.

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Memoirs of the Museum of Victoria 59(2): 337–354 (2002)

HYDROIDS (CNIDARIA: HYDROZOA) FROM SOUTHERN QUEENSLAND

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Abstract

Watson, J.E., 2002. Hydroids (Cnidaria: Hydrozoa) from southern Queensland. *Memoirs of Museum Victoria* 59(2): 337–354.

Fifteen species of hydroids were collected from a reef off Palm Beach, southern Queensland. Six records are new for Queensland; several species are circumtropical and two are cosmopolitan. *Symplectoscyphus sibogae* is recorded for the first time outside the type locality of Indonesia.

Introduction

A collection of hydroids was made on 9 May 2001 by the author using SCUBA from a reef approximately 1 km offshore from Palm Beach, southern Queensland (28°5′52′′S, 153°26′34′′E). In this area, a reef system extends 1–2 km offshore along the coast at a depth of 5–15 m, several higher parts of the reef being emergent as small islets. The water regime in the area is subtropical, the temperature at the time of the survey being 26°C. While not subject to strong currents the reefs are exposed to swells of the South Pacific Ocean.

The reef surrounding Cook Island off Burleigh Heads was inspected but yielded no hydroids. This island is a marine sanctuary, the surrounding waters being closed to recreational fishing; the invertebrate reef community is heavily grazed by fishes. In contrast, the reef off Palm Beach, outside the protected area and subject to considerable recreational fishing pressure, has fewer fish and the invertebrate community is much more diverse and abundant.

With the exception of *Macrorhynchia philippina* and *Aglaophenia sinuosa* which grow on exposed reef surfaces all species were small and cryptic, mostly occurring in sheltered crevices. Colonies of *M. philippina*, a tropical species, were quite small, indicating that it may be near the southern end of its range. Colonies of *A. sinuosa*, the other visually dominant hydroid, showed evidence of grazing by fish.

The collection, made in one dive over an area of several hundred square metres of reef, yielded 15 species of hydroids. Six species, *Eudendrium glomeratum, Hydrodendron daidalum, Salacia desmoides, Symplectoscyphus sibogae, Aglaophenia sinuosa* and *Obelia angulosa* and are new records for Queensland, having been previously recorded from temperate southern Australia and tropical northern Australia. Pennycuik (1959) recorded 46 species from the Queensland coast between the New South Wales border and north of Moreton Bay (latitudes 26–28°S). As only four species in the present collection (*Antennella secundaria, Synthecium campylocarpum (= S. patulum), Hincksella cylindrica, Macrorhynchia philippina)* were recorded from this region by Pennycuik, the number of known species from southern Queensland is thus increased to 57.

Several species in the present collection are circumtropical in distribution, and two (*Halecium sessile* and *Antennella secundaria*) are cosmopolitan. *Symplectoscyphus sibogae* is recorded for the first time outside the type locality of Indonesia. The collection also contains a small colony of a species of *Halecium* that could not be matched with any known species and may therefore be new. In the following descriptions only those synonymies relevant to Australia or the southern hemisphere are given. Material is deposited in Museum Victoria (NMV).

List of Species.

Eudendrium ?glomeratum Picard, 1951
Hebellopsis scandens (Bale, 1888)
Halecium sessile Norman, 1867
Halecium sp.

Hydrodendron daidalum (Watson, 1969).
Salacia desmoides (Torrey, 1902)
Dynamena quadridentata (Ellis and Solander, 1786)
Dynamena quadridentata (Ellis and Solander, 1786)
Symplectoscyphus sibogae (Billard, 1924)
Synthecium campylocarpum Allman, 1888
Hincksella cylindrica (Bale, 1888)
Antennella secundaria (Gmelin, 1791)
Lytocarpia brevirostris (Busk, 1852)
Aglaophenia simnosa Bale, 1888
Macrorhynchia philippina (Kirchenpauer, 1872)
Obelia angulosa Bale 1888

Anthoatheeatae

Eudendriidae L. Agassiz, 1862

Eudendrium Ehrenberg, 1834

Eudendrium ?glomeratum Picard

Eudendrium glomeratum Picard, 1951: 338.—Picard, 1955: 183.—Teissier, 1965: 14.—Watson, 1985: 213.—Boero and Cornelius, 1987: 244.—Watson, 1996: 78.—Watson, 1999: 7.
Eudendrium generalis von Lendenfeld, 1885: 351.—Thornely, 1904: 110.—Jäderholm, 1916: 3.
Eudendrium indopacificum Stechow, 1924: 59.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91283, several infertile stems to 4 mm high on barnacle, alcohol preserved.

Description. Stolon tubular, entwining substrate. Stems unfascicled, unbranched or sparingly branched in one plane; hydranths terminal on short pedicels or on single pedicels arising directly from stolon. Cnidome comprising small microbasic euryteles in tentacles and macrobasic euryteles on hydranth body. Colour, stems brown, hydranths white.

Distribution. Previously known in Australia from the tropical north and north-western coasts (Watson, 1999).

Remarks. The material is doubtfully assigned to *E. glomeratum* based on the presence of macrobasic euryteles distributed over the hydranth body. Although the nematocysts were not aggregated in pads on the hydranth as is normal in this species, reduction or loss of discrete pads and spreading of nematocysts over the entire hydranth body sometimes occurs (Watson, pers. obs.). If indeed *E. glomeratum* it is the most southerly record of the species in Australian waters.

Leptothecatae

Lafoeidae A. Agassiz, 1865

***Hebellopsis* Hadzi, 1913**

***Hebellopsis scandens* (Bale)**

Figure 1A

Lafoea scandens Bale, 1888: 758.—Billard, 1904: 481.—Billard, 1906: 174.—Warren, 1908: 272, 341, 349.
Hebella scandens.—Marktanner-Turneretscher, 1890: 214.—Millard, 1975: 182.—Migotto, 1996: 26.—Watson, 1996: 78.— Boero et al., 1997: 8.
Hebellopsis scandens.—Vannucci-Mendes 1949: 237.—Vannucci-Mendes, 1950: 85.—Calder, 1991: 43, 45, 95.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91284, infertile colonies epizoic on *Dynamena quadridentata*, alcohol preserved.

Description. Stolons tubular, very thin, wrinkled, closely adpressed to the hydrorhiza of *Dynamena quadridentata*, then running up stem of host. Hydrotheca tubular, issuing beside or between hydrothecae of host. Pedicel short, thin, tubular, wall of hydrotheca obtusely flexed about halfway along length, creased at bend; rim of hydrotheca circular, transverse to hydrothecal axis, slightly thickened and very weakly outrolled. Perisarc rather thin, fragile at hydrothecal margin. Hydranth with about 12 tentacles deeply withdrawn into hydrotheca (preserved material). Colourless.

Distribution. Cosmopolitan.

Remarks. The narrow stolon of *H. scandens* can only be distinguished from that of *D. quadridentata* as a thin, almost invisible tube lying closely beside the broad hydrorhiza of the host. The colonies of *H. scandens* contain neither straight nor slightly asymmetrical hydrothecae conforming to the accepted concept of *H. scandens*. Various authors (Vervoort, 1968; Vervoort and Vasseur, 1977; Boero et al., 1997) have reported straight and contorted hydrotheca in the same colony of *H. scandens* while hydrothecae of *H. scandens* from northern Australia were all contorted (Watson, 2000). While it is possible that *H. scandens* may undergo torsion as a response to ecological conditions it is nevertheless possible that there may be two closely related species involved, one with almost symmetrical hydrothecae and one with contorted hydrothecae. This can only be resolved with further collecting of an adequate live material over a wide geographical

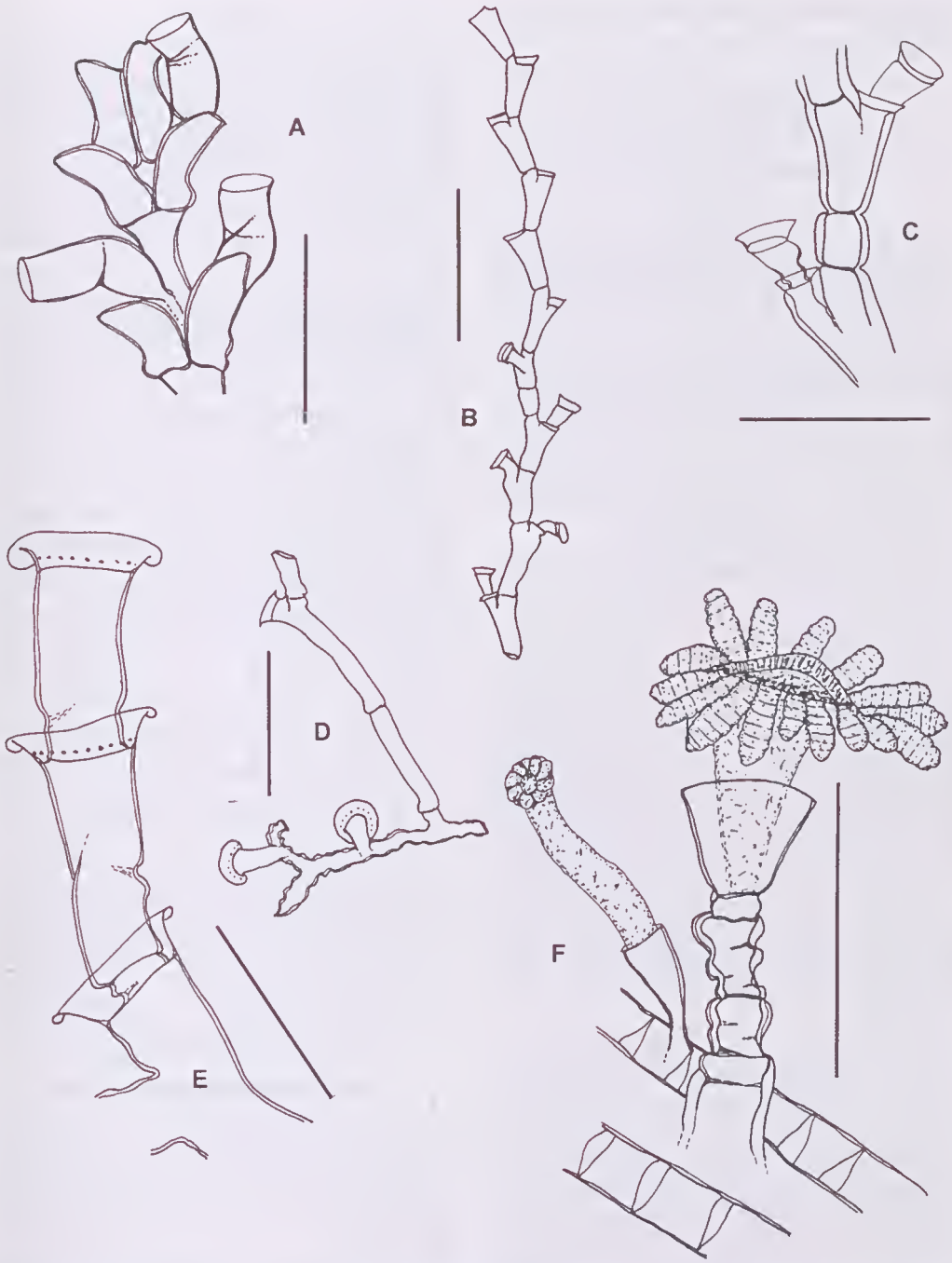

Figure 1. A, *Hebellopsis scandens* (Bale, 1888). Three hydrothecae on *Dynamena quadridentata*. B, C, *Halecium sessile* Norman, 1867. B, part of branch; C, stem internodes with hydrothecae. D, E. *Halecium* sp. D, part of colony with stolonal hydrothecae and erect stem; E, hydrophores and hydrothecae. F, *Hydrodendron daidalum* (Watson, 1969). Hydrorhiza, stem, hydrotheca and nematophore. Scale bar: A, D, C, 0.5 mm; B, 1 mm; E, 0.1 mm; F, 0.2 mm.

range and detailed investigation of reproductive strategies.

Haleciidae Hincks, 1868

Halecium Oken, 1815

Halecium sessile Norman

Figures 1B, C

Halecium sessile Norman, 1867: 205.—Ritchie, 1911: 812.—Stechow, 1913: 9.—Billard, 1927: 329.—Picard, 1958: 192.—Ralph, 1958: 331.—Pennycuik, 1959: 174.—Teissier, 1965: 21.—Vervoort, 1966: 100.—Redier, 1967: 386.—Vervoort, 1968: 95.—Schmidt, 1972: 42.—Cornelius, 1975: 406.—Millard, 1975: 154.—Watson, 1979: 234.—Ramil and Vervoort, 1992: 85.—Watson, 1994: 66.—Cornelius, 1995: 292.—Hirohito, 1995: 27.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F 91285, sparingly branched infertile colonies on various invertebrate substrates in crevices, alcohol preserved.

Description. Hydrorhiza reptant on substrate, stolons tubular. Stems monosiphonic, to 4 mm high, straight to slightly zig-zag, simple or sparsely branched near base. Stem internodes widening distally to hydrophore, nodes transverse, deep. Hydrophore short, primary hydrotheca very shallow, sessile or very closely adpressed to internode at level of node, shallow dish-shaped, sloping gently downwards away from internode, diaphragm distinct with a row of desmocytes above. Margin circular, not everted. Secondary hydrophores rare, on lower parts of stems, issuing from diaphragm of preceding hydrotheca, adcauline wall deeply indented at level of diaphragm. Perisarc smooth throughout, thick on proximal parts of stems, becoming very thin on hydrotheca. Hydranths robust, very extensible with about 24 stubby tentacles. Colour yellowish-brown.

Distribution. Cosmopolitan. Recorded in Australia from southern Queensland to Bass Strait.

Remarks. Secondary internodes are sometimes present between the main stem internodes. The material is assigned to *Halecium sessile* because of the almost straight stems and rather shallow, sessile primary hydrothecae. Although *H. sessile* was originally described from the cool temperate northern Atlantic there are now many records from other parts of the world, although some may be incorrect. Until a full world review of the species is undertaken, it is best to refer the Queensland material to *H. sessile*.

Halecium sp.

Figures 1D, E

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, small infertile colonies on *Obelia angulosa* (NMV F91294) and *Salacia desmoides* (NMV F91287), alcohol preserved.

Description. Stolon straggling, tubular, faintly to strongly rugose. Stems simple, very short, arising at intervals from hydrorhiza; basal stem internodes long, tubular, smooth, nodes deep, transverse, internode tumescent above node. Primary hydrophores given off singly from stolons and distally on stem internodes, outwardly bent, succeeding internode arising from a short apophysis below hydrophore. Primary hydrophore fairly short, cylindrical, surmounted by a deep, bowl-shaped hydrotheca; rim of hydrotheca strongly outrolled; diaphragm distinct, a clearly visible ring of peg-shaped desmocytes above. Secondary and tertiary hydrophores arising from diaphragm of primary hydrotheca, usually several proximal constrictions in perisarc of hydrophore just above diaphragm. Perisarc of colony rather thin throughout. Hydranth too contracted for tentacle count. Colour, white (preserved material).

Remarks. The colony is so minute that it was noticed only during microscopical examination of *Obelia angulosa*. The rather tangled stolon is easily detached from the substrate, the few stems being difficult to differentiate from the stolons. The specimen bears no resemblance to any of the smaller species of *Halecium* known from Australian waters. In size of colony and morphology of the hydrotheca it somewhat resembles *H. pygmaeum* Fraser, 1911; but dimensions are greater than those given by Hirohito (1995) for that species. Since many haleciids cannot be accurately identified in the absence of the gonosome, the material is not presently assigned to species.

Hydrodendron Hincks, 1874

Hydrodendron daidalum (Watson)

Figure 1F

Scoresbia daidala Watson, 1969: 111.—Watson, 1979: 234.—Watson, 1982: 92.—Stranks, 1993: 6.

Hydrodendron daidalum.—Rees and Vervoort, 1987: 22.

Material examined Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91286, infertile colony on the brown alga *Zonaria crenata*, alcohol preserved.

Description. Hydrorhiza a reticulating network covering algal surface; stolons very wide, flat and

ribbon-like, outer flanges with dark excavations. Hydrotheca distal on a short, thick, deeply rugose pedicel, deep bowl-shaped, rim circular, slightly everted. Nematothecae small, elongate urn-shaped, inserted on hydrorhiza beside hydrothecal pedicel, margin circular with everted rim. Hydranth with thick dome-shaped hypostome and 20–24 tentacles too large to retract into hydrotheca. Nematophore long, extensile, armed with a distal cluster of nematocysts. Colour, pale honey-yellow.

Distribution. This record extends the range of *H. daidalum* from southern Australian coastline to warmer subtropical waters of the central east coast. Endemic to Australia.

Remarks. H. daidalum is an obligate epiphyte of the small brown alga *Zonaria crenata*, the hydrorhiza and widely spaced pedicels forming an easily recognisable network on the algal thallus (Watson, 1969). Although Rees and Vervoort (1987) synonymised *Scoresbia* with *Hydrodendron* there are nevertheless several points of difference such as the simple, pedicellate stems and stolonal nematothecae that set *H. daidalum* apart from the typically branched colonies and cauline nematothecae of the accepted concept of *Hydrodendron.*

Sertulariidae Lamouroux, 1812

Salacia Lamouroux, 1816

Salacia desmoides (Torrey)

Figure 2A, B

Sertularia desmoides Torrey, 1902: 65.—Billard, 1924a: 66.—Fraser, 1938: 110.—Fraser, 1948: 247.—Stechow, 1923: 213.—Millard, 1975: 274.—Watson, 1996: 78.—Watson, 1997: 518.—Medel and Vervoort, 1998: 30.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91287, infertile colony on bryozoan, alcohol preserved.

Description. Hydrorhiza loosely reptant on substrate, stolon tubular. Stems short, unbranched, proximal stem of same diameter as stolon, athecate, ending in a strong V-shaped joint; stem thereafter thecate. Internodes slender, conical, nodes usually V-shaped, sometimes transverse. Hydrotheeae biseriate, paired, tubular, situated about two-thirds distance up internode, adcauline walls conjoined, parallel to internodal axis, straight to slightly convex, free adcauline wall directed outwards in convex curve, abcauline wall sinuous to flatly concave, floor of hydrotheca transverse to internode, straight or downwardly convex. Hydrotheca narrowing somewhat to margin; margin oblique to both internodal and hydrothecal axes, operculum of one valve attached inside abcauline margin. Perisare smooth, rather thick in lower stem region, thinner but firm on hydrotheeae. Hydranth with about 20 tentacles. Colour, deep yellow.

Distribution. California, south-west Indian Ocean, Mediterranean Sea. Recorded previously in Australia from Houtman Abrolhos Is, Western Australia. A new record for the Australian east coast.

Remarks. The internodes of the present material are much shorter and the hydrotheeae thus closer together than in specimens described from the Houtman Abrolhos Is by Watson (1997). The oblique margin with abcauline opercular valve is characteristic of the species.

Dynamena Lamouroux, 1812

Dynamena quadridentata (Ellis and Solander)

Figure 2C–F

Sertularia quadridentata Ellis and Solander, 1786: 57.—Lamarck, 1816: 2, 121.

Dynamena quadridentata.—Billard, 1925: 194, 222.—Trebilcock, 1928: 23.—Blackburn, 1938: 320.—Blackburn, 1942: 113.—Pennycuik, 1959: 193.—Ralph, 1961: 790.—Mammen,1965: 49.—Ralph, 1966: 159.—Shepherd and Watson, 1970: 140.—Millard, 1975: 266.—Gibbons and Ryland, 1989: 411.—Calder, 1993: 68.—Vervoort, 1993: 108.—Calder, 1995: 543.—Hirohito, 1995: 176.—Watson, 1996: 78.—Watson, 1997: 520.—Watson, 2000: 15

Pasya quadridentata.—Stechow, 1922: 148.—Stechow, 1923: 166.—Fraser, 1948: 239.

Pasythea (Sertularia) quadridentata.—Lamouroux, 1812: 183.—Lamouroux, 1816: 156.—Whitelegge, 1889: 193.—Nutting, 1927: 226.—Yamada, 1959: 58.

Dynamena thankasseriensis Mammen, 1965: 48.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91288, sparingly fertile colony on the bryozoan *Flustra* sp. and infertile colony on red alga, alcohol preserved.

Description. Hydrorhiza reptant on substrate, stolon flat, wide and ribbon-like, edged by a flange and canal with irregular, cusp-like indentations. Stems short, 2–4 mm long, widely spaced along hydrorhiza, proximal stem internode athecate with a strongly twisted V-shaped distal node, internodes thereafter hydrothecate, with 1–4 pairs of hydrotheeae, nodes between sets of hydrotheeae obscure, usually represented by constriction of perisare. Hydrotheeae biseriate, opposite,

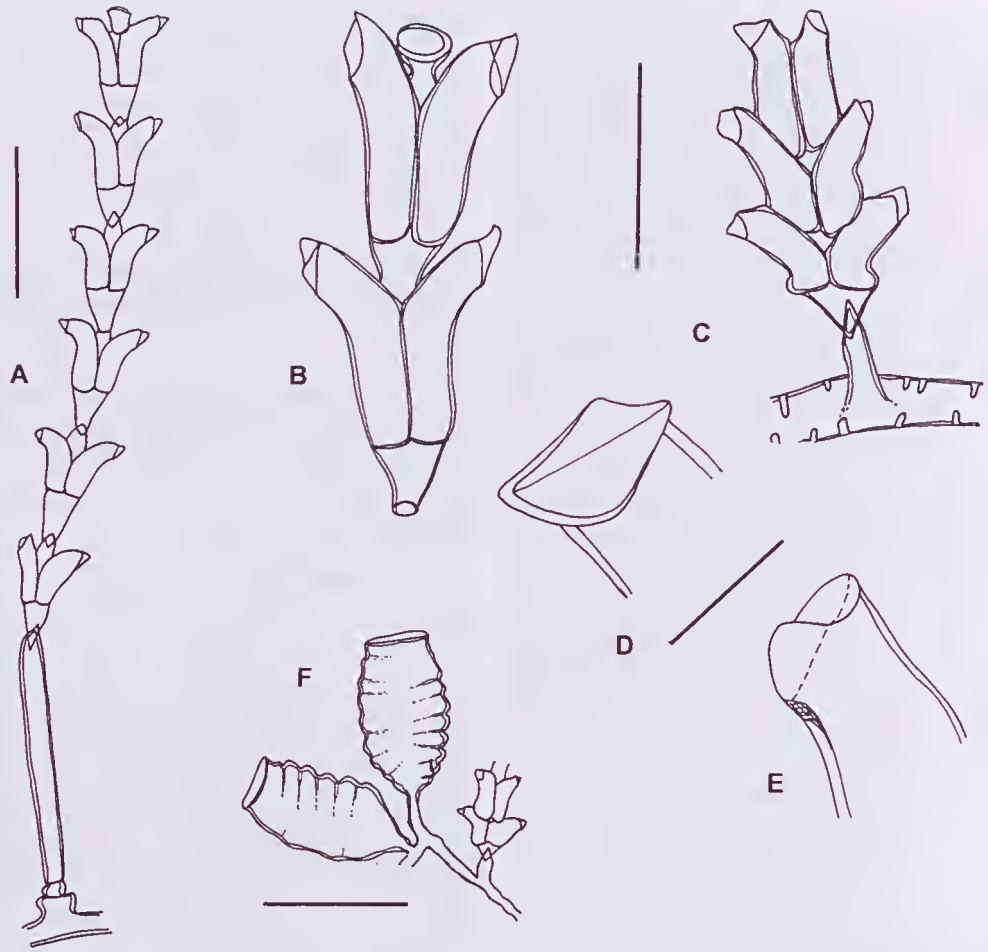

Figure 2. A, B, *Salacia desmoides* (Torrey, 1902). A, part of stem; B, internodes with hydrothecae. 2C– F, *Dynamena quadridentata* (Ellis and Solander, 1786). C, hydrorhiza and hydrothecate stem internode; D, anterior view of hydrotheca; E, lateral view of hydrotheca with opereulum; F, gonothecae. Scale bar: A, F, 1 mm; B, C, 0.5 mm; D, E, 0.1 mm.

elongate saccate, adeauline walls in partial contact aeross internode, conjoined walls straight to convex, remaining adnate and free adeauline wall bent outwards to margin, floor of hydrotheca transverse to decidedly rounded. In stems with single pairs of hydrotheeae the pairs separated by a narrow internodal neek; when more than one pair on internode, these closely adpressed, slightly overlapping, adeauline hydrotheeal wall overlapping base of that above; free adeauline wall short, convex; abeauline wall complexly eurved to almost straight; basal abeauline wall of first pair of group with pronounced lateral swelling, base of higher pairs acutely rounded, fitting into internode.

Floor of basal group transverse, thiek, a basal abeauline swelling forming a wide tunnel through perisare; base of adeauline wall with large knob, floor penetrated by a eentral funnel-shaped hydropore, direeted upwards. Margin with a pair of broad opposite lateral lobes, adeauline wall thickened and reeurved into a cusp; opereulum deliéate, of 2 valves. Perisare of stems and hydrotheea thiek, thinning to hydrotheeal margin.

Hydranth with about 16 tentaeles on a short, wrinkled eolumn, no caecum. Gonotheea large, arising from hydrorhiza on a moderately long eylindrieal pedieel; barrel-shaped, widest about middle; body with 6–8 deep annular eorrugations, apex transverse, truncate, with thickened rim.

Gonophore slender, cigar-shaped containing numerous small ova. Colour, honey-brown.

Distribution. Circumglobal in tropical waters. Previously recorded from tropical Australia.

Remarks. The annular corrugations on the gonotheeae are usually not all the same depth around the body, tending to become shallower on one side. In the present material there is no submarginal abeauline intratheeal perisareal thickening as described in specimens from Darwin (Watson, 2000), the colonies being more like those reported from the Houtman Abrolhos Is (Watson, 1997). In most hydrothecae a strand of tissue infested with numerous large ovoid diatoms extends from the hydranth along the inner abeauline wall of the hydrotheca towards the margin. *Hebellopsis scandens* is a common epizoite of the colonies.

Sertularella Gray, 1848

Sertularella minuscula Billard

Figure 3A–E

Sertularella minuscula Billard, 1924b: 648.—Billard, 1925: 139.—Leloup, 1932: 161.—Pennycuik, 1959: 195.—Hirohito, 1974: 18.—Cooke, 1975: 98.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91289, small fertile colony on test of a solitary ascidian, alcohol preserved.

Description. Stolon tubular, rugose; stems to 5 mm high, unbranched, lower stem of same diameter as stolon, proximal internode atheeate, stem thereafter theeate, internodes with 2 alternate hydrotheeae, nodes distinct, oblique, sloping alternately left and right, usually a small tumeseenee above and below node.

Hydrotheeae on both stolon and caulus, all of

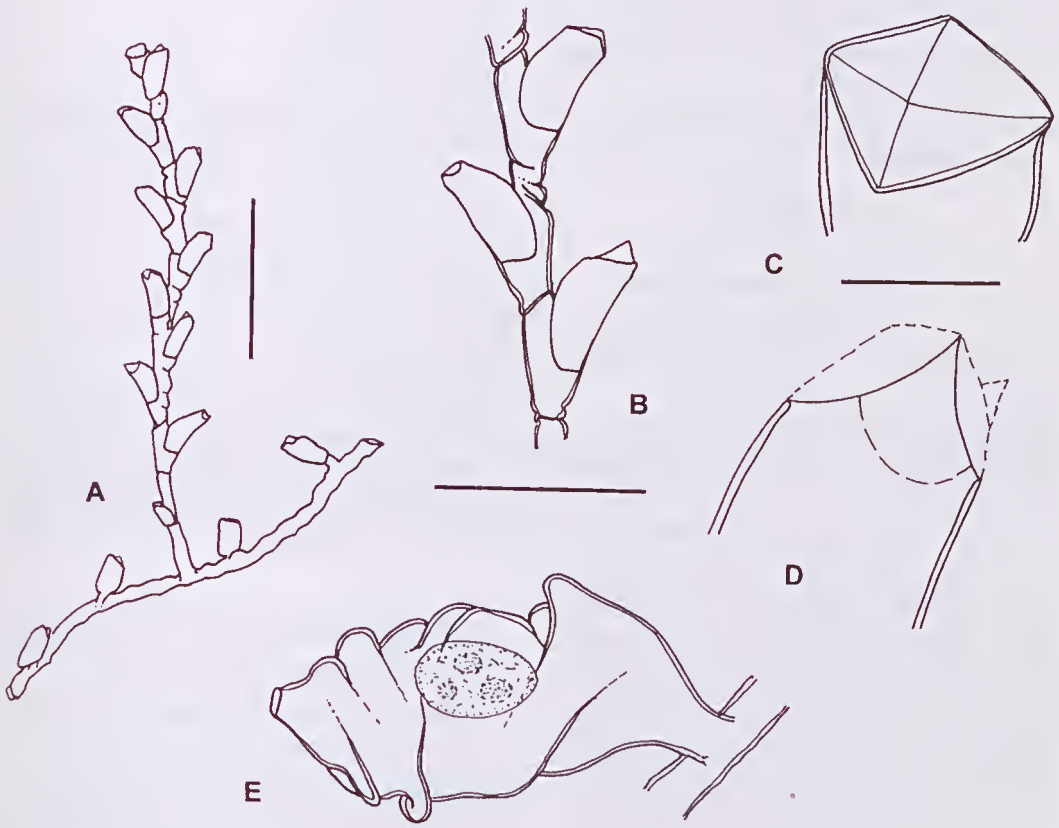

Figure 3. A–E, *Sertularella minuscula* Billard, 1924. A, stolon with single hydrotheeae and erect theeate stem; B, hydrotheeate stem internodes; C, anterior view of hydrotheea with operculum; D, lateral view of hydrotheca and opereulum; E, female gonotheea. Scale bar: A, 1 mm; C, D, 0.1 mm; B, E, 0.5 mm.

same shape. Stolonal hydrothecae widely spaced, on a short pedicel, cauline hydrothecae sessile, displaced slightly towards front of stem; hydrotheca tubular, narrowing slightly to margin, adcauline wall convex, about half free of internode, abcauline wall contiguous with border of internode, almost straight to weakly concave; floor of hydrotheca transverse to internodal axis; margin quadrangular (anterior view), rim with 4 cusps, lateral cusps sharp with deep semicircular embayment between, operculum of four fragile triangular valves. Hydranth with 10–12 tentacles; no evidence of an abcauline caecum in contracted or extended hydranths. Gonotheca irregularly obovoid, usually widening distally, body deeply crumpled, some gonothecae with 1 or 2 deep flanges, body narrowing into a rather wide, smooth pedicel, some arising from within stolonal hydrothecae, apex of gonotheca a short inverted funnel, orifice circular. An oval body in 1 gonotheca may be an ovum. Perisarc rather thin, fragile at hydrothecal margin, operculum and gonotheca. Colour, colony pale yellowish-white.

Distribution. Indonesia, Caribbean, Micronesia, Japan and Queensland.

Remarks. The species is remarkable for its small size and delicacy and the crumpled appearance of the gonotheca.

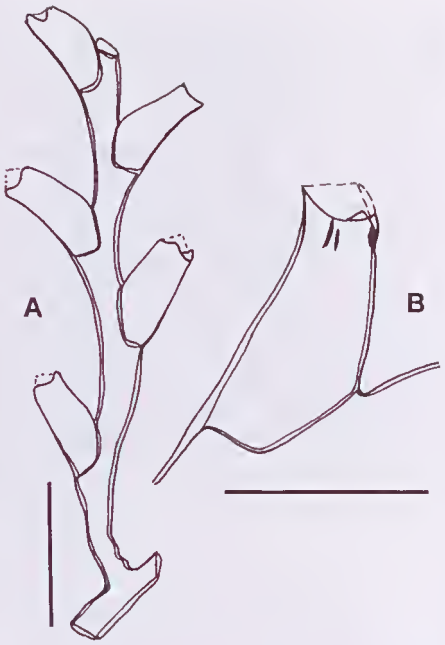

Figure 4. A, B, *Symplectoscyphus sibogae* (Billard, 1924). A, part of stem; B, hydrotheca. Scale bar: A, 1 mm, B, 0.5 mm.

Symplectoscyphus Marktanner-Turneretscher, 1890

Symplectoscyphus sibogae (Billard)

Figure 4A, B

Symplectoscyphus sibogae Billard, 1924: 69.—Billard, 1925: 166.—Vervoort, 1993: 241.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91295, infertile stem detached from substrate, malinol mounted microslide preparation.

Description. Stolon thick-walled, tubular. Stem 4 mm high, straight, with 5 alternate hydrothecae, an indistinct transverse basal node between hydrorhiza and first hydrotheca; no other obvious nodes. Hydrothecae large, tubular, arching outwards from stem, narrowing to margin, adnate adcauline wall short, parallel with internode, free adcauline wall weakly convex to almost straight, abcauline wall contiguous with border of internode, faintly concave; floor of hydrotheca narrow, transverse to internodal axis. Margin everted with 3 fairly sharp cusps with shallow embayments between; a large internal submarginal cusp at base of each embayment; operculum of 3 delicate triangular valves. Perisarc thick and smooth throughout; opercular valves thick. Colour white.

Distribution. This is the second record of the species, the original record being from the type locality in Indonesia.

Remarks. Although the small colony is obviously juvenile, it nevertheless conforms to descriptions of the species. Because of their position below the embayments the marginal cusps are rather difficult to see. The species is notable for its smooth perisarc, and large, elegant hydrothecae with great length free of the internode.

Syntheciidae Marktanner-Turneretscher, 1890

Synthecium Allman, 1872

Synthecium campylocarpum Allman

Figure 5A–C

Synthecium campylocarpum Allman, 1888: 78.—Marktanner-Turneretscher, 1890: 248.—Farquhar, 1896: 466.—Stechow, 1913: 127.—Jäderholm, 1919: 14.—Totton, 1930: 169.—Ralph, 1958: 347.—Yamada, 1959: 52.—Hirohito, 1969: 18.—Watson, 1996: 78.—Watson, 2000: 40.

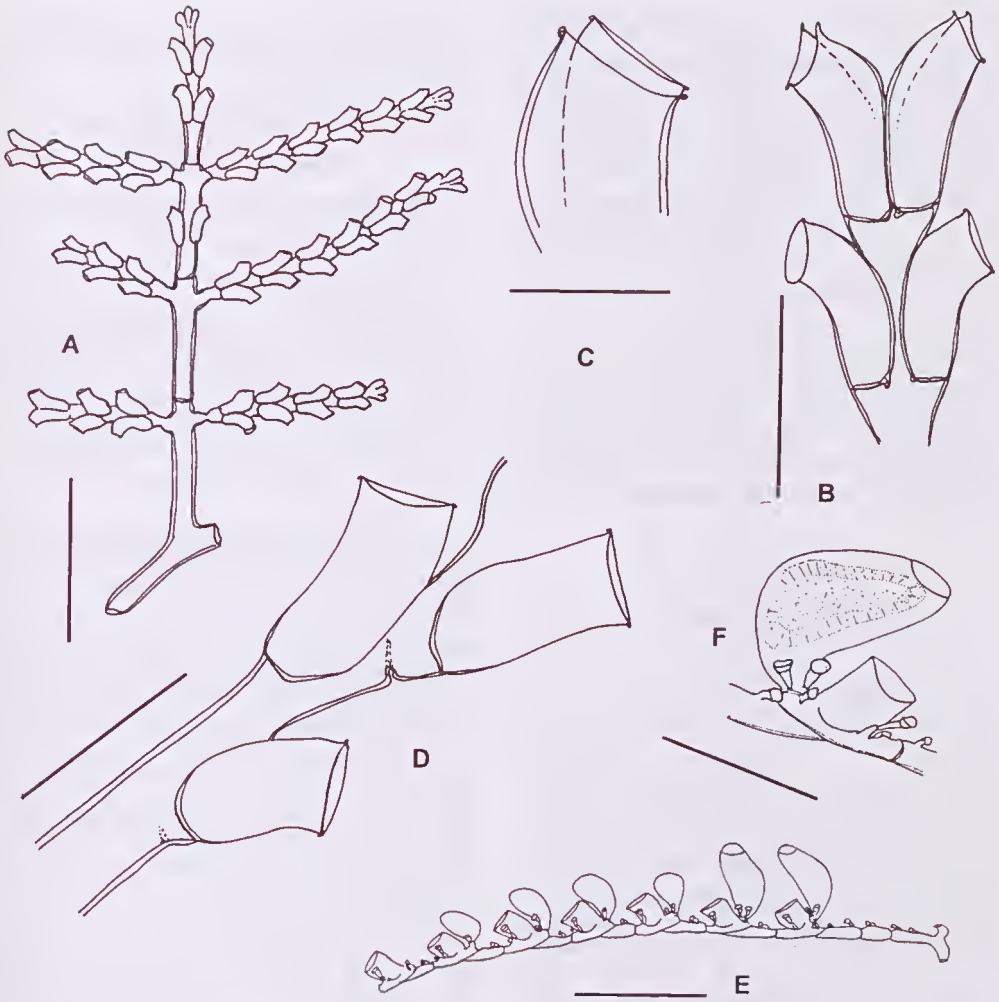

Figure 5. A–C, *Syntheciuin campylocarpum* Allman, 1888. A, whole stem; B, hydrothecate hydrocladial internodes; C, hydrotheca showing regrowth of margin from within hydrotheca. D, *Hincksella cylindrica* (Bale, 1888). Part of stem. E–F, *Antennella secundaria* (Gmelin, 1791). E, fertile hydroeladium; F, female gonotheca (after Watson, 2000). Scale bar: A, 2.5 mm; E, 1 mm; B, D, F, 0.5 mm; C, 0.1 mm.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15, NMV F91900, three short, infertile stems on calcareous bryozoan.

Description. Hydrorhiza thick, tubular. Longest stem 12 mm high, straight, hydrocladia opposite, three widely separated pairs almost perpendicular to axis of stem; stem internodes long, cylindrical, smooth, nodes transverse, just above hydrocladia, a subpposite pair of hydrotheca between, halfway along some internodes. Hydrocladia inserted on short, tubular apophyses narrowing distally but without obvious distal node.

Hydrothecae paired, opposite, tubular, of same diameter throughout length, supported on a short conical section of internode between pairs; adcauline walls in contact or slightly separated on internode, adnate walls parallel to internode, straight, or slightly convex, free wall convex or continuing bend of adnate wall, abcauline wall sinuous, basally convex, concave behind margin; floor of hydrotheca convex, thickened, a hydropore at base of abcauline wall. Margin faintly sinuous (lateral view), tilted upwards to internode, rim slightly but sharply outrolled, many margins

regenerated by growth of new hydrotheca from deep within old, abcauline wall of new hydrotheca free, visible, adcauline wall attached to wall of primary hydrotheca. Hydranth with about 12 long tentacles. Perisarc of stem, hydrocladia and hydrothecae thick and smooth, thinner on hydrothecal margin. Colour, pale yellow.

Distribution. Type locality, New South Wales (Allman, 1888). Tropical northern Australia and New South Wales. Previously recorded from southern Queensland as *S. patulum* by Pennycuik (1959).

Remarks. The distinction between *Synthecium campylocarpum* and *S. patulum* (Busk, 1852) was discussed by Watson (2000). The present material is assigned to *S. campylocarpum* because of the shorter hydrothecae, less pronounced marginal sinuosity of the hydrotheca and yellow colour of the colony.

Hincksella Billard, 1918

Hincksella cylindrica (Bale)

Figure 5D

Sertularella cylindrica Bale, 1888: 765.
Synthecium cylindricum.—Ritchie, 1911: 847.—Stechow, 1923: 150.—Fraser, 1948: 234.
Hincksella cylindrica.—Blackburn, 1937: 173.—Pennycuik, 1959: 189.—Vervoort, 1959: 245.—Vervoort,1968: 101.—Millard, 1975: 232.—Watson, 1979: 234.—Calder, 1993: 68.—Vervoort, 1993: 193.—Watson and McInnes, 1999: 108.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91901, several infertile stems detached from substrate, malinol mounted mieroslide preparation.

Description. Stems fragile, to 4 mm high, proximal part of stem athecate, upper stem with up to 6 hydrothecae, stem internodes wide, cylindrical, curved, smooth, an indistinct slightly oblique node below some hydrothecae. Hydrothecae subopposite to alternate, cylindrical, adnate adcauline wall convex, free adcauline wall about one quarter length of adnate wall, continuing curve of fused wall, abcauline wall concave; floor of hydrotheca transverse to internode, narrow. Margin circular, rim weakly outrolled. Perisarc of lower stem thick, thinning markedly on hydrothecae, most of which have collapsed in mounting. Colour, white.

Distribution. Type locality, Port Jackson, New South Wales (Bale, 1888). Southern Australia, Pacific coast of North America, Caribbean. Previously recorded from southern Queensland.

Remarks. Hincksella cylindrica is an uncommon species, usually found as single stems or colonies consisting of only a few stems.

Halopteriddae Millard, 1962

Antennella Allman, 1877

Antennella secundaria (Gmelin, 1791)

Figure 5E–F

Sertularia secundaria Gmelin, 1791: 3856.
Aglaopheuia secundaria.—Lamouroux, 1824: 19.
Antennella secundaria.—Pennycuik, 1959: 176.—Watson, 1973: 183.—Millard, 1975: 332.—Ryland and Gibbons, 1991: 525.—Ramil and Vervoort, 1992: 143.—Medel and Vervoort, 1995: 35.—Watson, 1996: 78.—Schuehert, 1997: 14.—Calder, 1997: 29 (full synonymy).—Watson, 1997: 522.—Watson, 2000: 45.
Antenella secundaria.—Stechow and Müller, 1923: 473.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91290, fertile colonies on barnacles and solitary ascidians in creviees, alcohol preserved.

Description. Stems (hydrocladia) simple, unbranched, to 6 mm high, arising from a tubular stolon; proximal part of hydrocladium with one to three athecate internodes, nodes transverse, each internode bearing one or two nematothecae, distalmost node strongly oblique. Internodes thereafter alternately theeate and athecate, proximal node of thecate internode strongly oblique, passing beneath hydrotheca, distal node transverse below hydrothecal margin.

Hydrotheca occupying almost entire internode, facing forward, deep cup-shaped, walls almost parallel, free adcauline wall straight to slightly concave, adnate part convex, curving back to small hydropore at base of abcauline wall; margin circular, slightly sinuous. Nematothecae bithalamic, small, 2 on athecate internode, basal chamber stout, cup small, foreshortened on adcauline side; mesial inferior stout, adcauline side of cup foreshortened, just reaching base of hydrotheca, lateral nematotheca borne on a long, slender pedicel where adcauline wall of hydrotheca becomes free, cup broad and shallow, excavated on adcauline side, not quite reaching hydrothecal margin; a small mesial superior nematotheca inserted beneath hydrotheca. Female gonothecae obovoid, somewhat flattened, facing forward, borne on a short, thick pedicel beside mesial inferior nematotheca; 2 large nematothecae at base; basal chamber of nematotheca long, cup wide, shallow, excavated on side facing gonotheca. Orifice of gonotheca distal, subcircular, closed by a

thin opereulum, gonotheca containing a single planula larva almost filling gonotheca at maturity. Colour, golden yellow, planula shining white.

Distribution. A cosmopolitan speeies with temperate and tropical distribution in Australian waters.

Remarks. A few male gonothecae are present on the stems. The speeies conforms in all respects with descriptions of *A. secundaria* from other Australian localities (Watson, 2000).

Aglaopheniidae Marktanner-Turneretscher, 1890

Lytocarpia Kirchenpauer, 1872

Lytocarpia brevirostris (Busk)

Figure 6A–D

Plumularia brevirostris Busk, 1852: 397.
Aglaophenia brevirostris.—Bale, 1913: 135.
Thecocarpus brevirostris.—Billard, 1913: 89.—Briggs, 1918 : 34, 45.—Stechow, 1919: 137.—Bedot, 1922: 157.—Jarvis, 1922: 350.—Pennyeuik, 1959: 187.—Vasseur, 1974: 158.—Millard, 1975: 454.
Lytocarpia brevirostris.—Stechow, 1922: 151.—Stechow, 1923: 245.—Ryland and Gibbons, 1991: 545.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91291, infertile colony on polychaete tube, alcohol preserved.

Description. Hydrorhiza a stout tube from whieh stems arise at intervals. Stems short, pinnate, to 10–15 mm high, proximal part of stem ahydrocladiate, some with a supplementary fascieular tube running part way up stem. Stem internodes short, nodes poorly defined, transverse to slightly oblique; hydrocladia alternate, about 2 mm long, 1 per stem internode, inserted on a short apophysis on front of stem; a small open pore (mamelon) on base of apophysis.

Hydroeladial internodes long, base of eaeh strongly displaced with respect to next one, node present, indistinct or absent at point of displaeement, internode with 1 eomplete septum beneath posterior quarter of hydrotheea and another, partial, below saddle in hydrotheca. Hydrotheea elongate, parallel with internode, margin separated from mesial nematotheca by deep saddle; margin sloping forward with a long, sinuously curved, blunt anterior cusp, followed by 3 pairs of deeply incised, sharply pointed cusps, the third pair usually obscured by lateral nematothecae; base of hydrotheea with a short, forwardly pointing intratheeal septum. Mesial hydrotheeal nematotheca rather short, digitate, at an angle of about 50° to internode, apex about level with anterior hydrotheeal eusp, orifice small, shallowly canaliculate; lateral nematotheca flask-shaped, laying almost parallel to internode, orifice small, eanalieulate down to internode. Two cauline nematothecae, one above and one below hydroeladial apophysis; same shape as laterals, but base a little more inflated, orifice of upper facing away from apophysis, orifice of lower facing up and outwards. Colour, yellow.

Distribution. A eommon Indo-Pacific species previously recorded from Queensland.

Remarks. The colony was found on the tube of a worm of the genus *Eunice*. The tough, mucilaginous tube of this polyehaete genus is a favoured substrate of hydroids in tropical and temperate waters (Watson, 2000).

Aglaophenia Lamouroux, 1812

Aglaophenia sinuosa Bale

Figure 6E–H

Aglaophenia sinuosa Bale, 1888: 790.—Whitelegge, 1889: 194.—Jäderholm, 1916: 19.—Watson, 1994: 67.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91292, infertile colonies of many stems on exposed rock surfaces, alcohol preserved.

Description. Hydrorhizal stolons thick, reptant on substrate; stems monosiphonic, up to 70 mm long, internodes short, wide, nodes transverse to slightly oblique, sloping in different directions, a deep shoulder at node. Hydroeladia to 10 mm long, alternate, one per cauline internode, inserted on a short apophysis. Hydrocladial internodes deep, nodes slightly oblique, distinct, a weak intranodal septum sometimes below posterior of hydrotheca.

Hydrotheea saccate, base eonvex, posterior wall deeply indented, a thiek septum passing down into body from junction of abeauline wall with mesial nematotheea, edge of septum ragged in anterior view. Margin sloping sharply downwards to internode; margin (lateral view) with a thick rostrum overtopping median anterior tongue-shaped eusp, flanked by 2 pairs of tongue-shaped cusps and a pair of sharp, upwardly pointed eusps behind nematothecae. In anterior view, first pair of cusps outwardly direeted, second pair produced inward over hydrotheeal margin, third pair slightly outwardly directed; the entire margin having a fluted appearance. Mesial nematotheea short, free end blunt, reaching level of intratheeal septum, margin widely canalieulate, curving down to junction with hydrotheca.

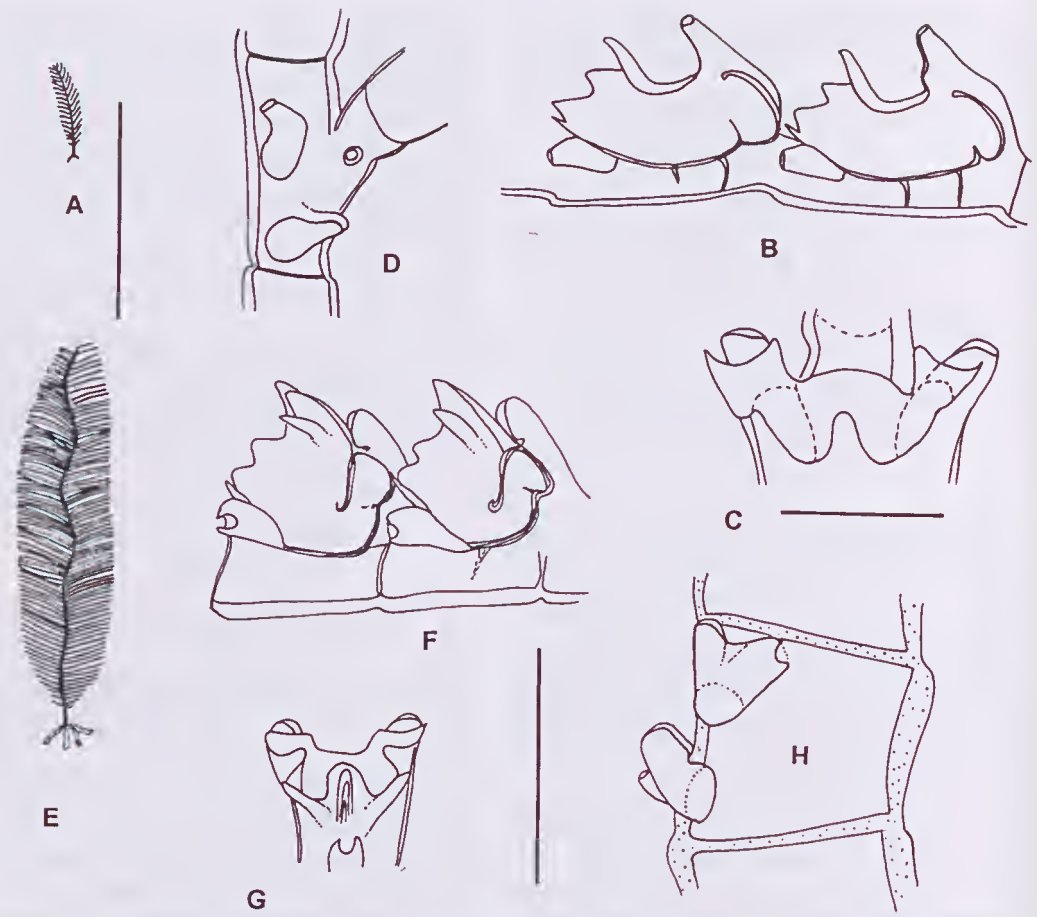

Figure 6. A–D, *Lytocarpia brevirostris* (Busk, 1852). A, whole stem; B, hydrothecate hydrocladial internodes; C, hydrotheca, anterior view; D, stem internode with cauline nematothecae and mamelon. E–H, *Aglaophenia sinuosa* Bale, 1888. E, single stem from colony; F, hydrocladial hydrothecae; G, hydrotheca, anterior view; H, front of stem showing oblique internodes and cauline nematothecae (hydrocladia not shown). Scale bar: A, E, 20 mm; B, C, D, F, G, H, 0.3 mm.

Lateral nematothecae conical, widening from base to margin, base parallel with internode, orifice circular, level with node, excavated down to internode. Three cauline nematothecae: i) on front of internode at base of apophysis, facing inwards, ii) between apophysis and proximal node, facing outwards, iii) one behind apophysis; all nematothecae with 2 opposite orifices. Colour, dark brown.

Distribution. Tasman Sea, New South Wales. Not previously recorded from the Queensland coast; possibly at the northern end of its range.

Remarks. Aglaophenia sinuosa is easily recognisable among Australian aglaopheniid hydroids by the sinuous bends at intervals along the stem, each bend marking a reversal of the direction in which the hydrocladia face so that succeeding groups of hydrocladia alternately face frontwards and backwards. The marginal hydrothecal cusps are quite difficult to describe as their apparent position and morphology changes according to the angle of view; in lateral view the cusps may appear as sharply pointed whereas in anterior view some are tongue-shaped and inwardly and outwardly fluted. There is some discrepancy between the morphology of the hydrotheca of the present material and Bale's description and figure of the species, his specimens having two intrathecal septa and more upright lateral nematothecae. This may be a rather variable species, but not enough is yet known of its range of variation.

Macrorhynchia Kirchenpauer, 1872

Macrorhynchia philippina (Kirchenpauer)

Figure 7A, B

Macrorhynchia philippina Kirchenpauer, 1872: 19.—Steehow, 1923: 241.—Stechow and Müller, 1923: 475.—Steehow, 1924: 69.—Steehow, 1925: 258.—Hirohito, 1983: 78.—Rees and Vervoort, 1987: 177.—Watson, 1996: 79.—Migotto, 1996: 40.—Watson, 1997: 538.—Calder, 1997: 62.—Watson, 2000: 67.

Aglaophenia philippina.—Kirchenpauer, 1872: 29, 45.

Lytocarpus philippinus.—Kirkpatriek, 1890: 604.—Bale, 1888: 786.—Billard, 1913: 78.—Bale, 1914a: 6.—Bale, 1915: 293.—Jäderholm, 1916: 7.—Briggs and Gardner, 1931: 193.—Millard, 1958: 220.—Pennycuik, 1959: 186.—Millard and Bouillon, 1973: 93.—Millard, 1975: 449.

Material and record. Palm Beaeh, Queensland, 2 km offshore, depth 5–15 m, NMV F91293, many infertile colonies on roek faees, aleohol preserved.

Description. Hydrorhiza reptant on substrate, stems plumose, to 30 mm high, faseieled, subpinnately branched, stem internodes indistinct. Hydroeladia frontal on branch, alternate, hydroeladial internodes short, deep, nodes slightly oblique; two partial intranodal septa, one passing down from base of hydrotheca, the other from base of lateral nematotheca.

Hydrotheca saccate, adcauline wall flat or slightly convex in contaet with internode, free part attached to lateral nematotheca, a deep proximal indentation in base of adcauline wall, abcauline sinuate, rising abruptly behind margin, a deep V-shaped septum penetrating hydrotheca between mesial nematotheca and margin. Margin eireular with a pair of opposite, low lobes. Mesial nematotheca ereet, tubular, parallel with hydrotheeal abcauline wall, reaching to or beyond hydrotheeal margin, tapering a little distally, terminal orifiee eireular, a little exeavated on adcauline side, a secondary orifiee above junction with hydrotheca and another, internal, conneeting with hydrotheca. Lateral nematotheca long, tubular, inclined forward beyond hydrotheeal margin, orifiee eireular or slightly exeavated. A eauline nematotheca on branch at base of hydroeladium, short, body inflated, orifiee eireular, on a short neek. Colour, colonies glowing white in situ, stems of preserved material pale brown, hydroeladia greyish-white.

Distribution. Macrorhynchia philippina is a very common eireumglobal tropieal speeies. It oeeurs throughout the Australian tropics (Watson 2000).

Remarks. None of the numerous colonies of *M. philippina* observed off Palm Beaeh were more than a few eentimetres high, growing elose to the roeky substrate in exposed situations. Although the colonies were very small for this species they showed no evidenee of grazing by fish, thus suggesting that dwarfism may be due to the speeies being elose to the southern end of its temperature range.

Campanulariidae Johnston, 1836

Obelia Péron and Lesueur, 1810

Obelia angulosa Bale

Figure 7C

Obelia angulosa Bale, 1888: 752.—Whitelegge, 1889: 195.—Steehow, 1914: 129.—Stechow, 1919: 49.—Vannueei-Mendes, 1951b: 115.—Blaneo, 1968: 210.—Stranks, 1993: 4.—Blaneo, 1994: 193.—Migotto, 1996: 123.

Material examined. Palm Beach, Queensland, 2 km offshore, depth 5–15 m, NMV F91294, many infertile eolonies on barnaeles, sponges and aseidians, aleohol preserved.

Description. Hydrorhiza tubular, reptant on substrate. Stems to 6 mm high, monosiphonie, lower stem smooth, unbranehed, a series of annulations above base, upper stem region slightly sympodial, simple, diehotomously or triehotomously branehed, internodes moderately long, tubular, straight, widening a little distally, nodes oblique, faint to absent, proximal part of internode deeply annulated. Hydrotheeal pedieels usually alternate, given off at an aeute angle distal on internode, pedieels variable in length, annulated throughout or with a eentral smooth seetion. Hydrotheca graeefully eampanulate, diaphragm transverse to hydrotheeal axis, margin faintly everted. Hydranth robust, number of tentaeles eould not be eounted. Perisare smooth throughout, fairly thiek on internodes, pedieels, and around upper body of hydrotheca. Colour, lower stems shining brown, upper stems fading to white.

Distribution. Not previously reeorded from Queensland; known from New South Wales (Bale, 1888) and Vietorian waters (Watson, unpubl.) and South Ameriea.

Remarks. This very delieate speeies is easily distinguished from its more eommon southern Australian eongener, *Obelia dichotoma* (Linnaeus, 1758), by its smaller size and almost invariably transverse diaphragm. The eoenosare of the hydrorhiza and stems and the tentaeles of the speeimens are paeked with zooxanthellae.

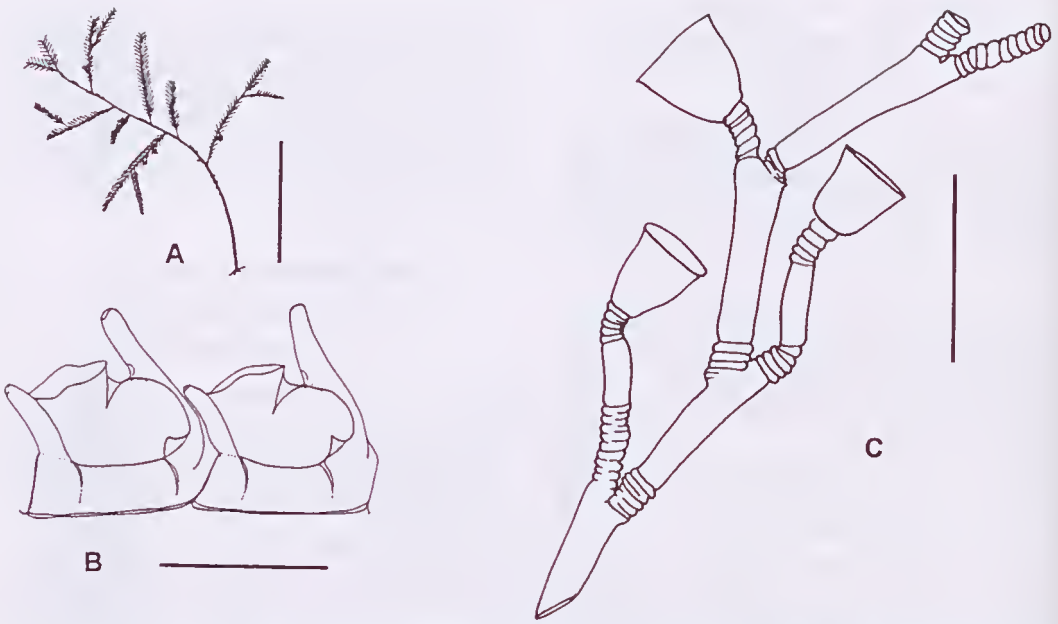

Figure 7. A, B, *Macrorhynchia philippina* (Kirchenpauer, 1872). A, whole stem; B, hydroeladial hydrotheeae (after Watson, 2000). C, *Obelia angulosa* Bale, 1888. Stem internodes and hydrotheca. Scale bar: A, 50 mm; B, 0.3 mm; C, 0.5 mm.

O. angulosa is the most abundant species in the collection although it is probably seasonal and likely to be absent at other times of year.

Acknowledgements

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A REVISION OF THE AUSTRALIAN GENUS *UMBILIA* (GASTROPODA: CYPRAEIDAE)

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Abstract

Darragh, T.A., 2002. A revision of the Australian genus *Umbilia* (Gastropoda: Cypraeidae). *Memoirs of Museum Victoria* 59(2): 355–392.

Umbilia, an endemic Australian genus of cool-water cowry, comprises 11 species ranging in age from Late Oligocene to Recent, of which four species are known only in the living fauna. Fossil species occur in the Eucla, St Vincent, Murray, Otway, Bass and Gippsland Basins, and living species range from Western Australia to central Queensland. Species of the genus probably have no free-swimming larval stage, so that there is considerable morphological variability which has led to the creation of many synonyms. Two subgenera are recognised here, *Umbilia* (*Umbilia*), with ten species, *U. prosila* sp. nov., *U. leptorhyncha*, *U. petilirostris* sp. nov., *U. platyrhyncha*, *U. angustior*, *U. eximia* (= *brevis*, *maecoyi*, *frankstonensis*, *montistuarthae* and *sphaerodoma*), *U. hesitata* (= *beddomei*, *cera*, *howelli* and *tatei*?), *U. siphonata* (= *breviplicata*), *U. armeniaca* and *U. capricornica*, and *U.* (*Palliocypraea*) with one species, *U.*(*P.*) *gastroplax*. A possible ancestor of *Umbilia*, *Palaeocypraea*? *eripuides*, from the Upper Paleocene–Lower Eocene, of the Chatham Is, New Zealand, is newly described. *Rhynchocypraea* Cossmann, 1898 (type species *Cypraea leptorhyncha* McCoy) is synonymised with *Umbilia*.

Introduction

Umbilia is an endemic Australian genus of cowry. Living species are found in deep water from the southern coast of Western Australia and along the east coast to the Capricorn Channel area of Queensland. Fossil species are known from the Eucla, St Vincent, Murray, Otway, Bass, and Gippsland Basins in rocks ranging in age from Late Oligocene to Late Pliocene. In general, fossil specimens are not common except in the Middle Miocene Fyansford and Gellibrand Formations of the Otway Basin. One of the extant species (*U. hesitata*) also has fossil records (Miocene-Pliocene).

Umbilia is a member of an endemic group of Australian cowries that includes *Notocypraea*, *Austrocypraea* and *Zoila* (Wilson, 1985). The present paper reports results of part of a wider, comprehensive study of all the Australian fossil cowries.

Previous work. The first fossil species of *Umbilia* to be described, *Cypraea eximia* G. B. Sowerby I, 1845, was based on a specimen collected by P. E. Strzelecki allegedly from Tasmania. MeCoy (1867a, 1875, 1876) described another species, *Cypraea* (*Aricia*) *platyrhyncha* from Torquay as well as illustrating Victorian examples of Sowerby's species and describing a new variety of it, *Cypraea* (*Aricia*) *eximia* var. *brevis*. He also described *Cypraea gastroplax* (MeCoy, 1867a), now included in the subgenus *Umbilia* (*Palliocypraea*) and *Cypraea* (*Luponia*) *leptorhyncha* (MeCoy, 1877) herein regarded as an *Umbilia*. Tate (1890) listed previously described species, recorded new occurrences and described two new taxa, *Cypraea sphaerodoma* and *C. amygdalina*, the latter renamed *C. tatei* by Cossmann (1903) owing to preoccupation of Tate's original name. Tate also noted a general resemblance of *Cypraea eximia* to the living *C. umbilicata* G. B. Sowerby I (= *hesitata* Iredale), type species of *Umbilia* Jousseaume, 1884.

Pritchard (1896) described a new variety of MeCoy's species, *Cypraea platyrhyncha* var. *angustior* from northern Tasmania, that is here elevated to specific rank. Harris (1897) placed *C. eximia* and *C. sphaerodoma* in *Umbilia*, which he regarded as a subgenus of *Cypraea*. Cossmann (1898) erected *Rhynchocypraea* for *Cypraea leptorhyncha*. This is synonymised with *Umbilia* (*Umbilia*) in this paper. In 1906 Cossmann erected *Palliocypraea* as a subgenus of his genus *Rhynchocypraea*, with type species *Cypraea*

gastroplax McCoy. Chapman (1922) described *Cypraea siphonata* from near Waikerie, South Australia, a species now included in *Umbilia*. In 1926, Schilder named *Gisortia breviplicata* based on Tate's (1890) description of *C. sphaerodoma* var. In 1932, Schilder listed all previously described taxa under the genus *Umbilia* and erected *U.* (*U.*) *eximia maccoyi* based on McCoy's figures (McCoy, 1876) of *Cypraea eximia*.

In 1935, Schilder revised all the Tertiary cowries from Australia, describing many new taxa based on material (much with poor locality data) in European collections. *U.* (*U.*) *brevis montismarthae* and *U.* (*U.*) *brevis frankstonensis* were the new taxa of *Umbilia* so erected. He had little idea of the variability of the taxa owing to the relatively small number of specimens available to him (18 specimens of *Umbilia*) and he had no idea of their stratigraphic positions. Schilder regarded both *Rhynchocypraea* and *Palliocypraea* as subgenera of *Umbilia*, maintaining *Rhynchocyprea* as a montotypic subgenus and assigning *Gisortia breviplicata* and *Cypraea siphonata* to *Palliocypraea*. The last fossil species to be erected, *U. cera*, was described by Cotton (1947) from the Dry Creek Sands of the St. Vincent Basin, South Australia.

There are four known living species of *Umbilia*: *U.* (*U.*) *armeniaca* (Vereo, 1912) from southern Western Australia and South Australia; *U.* (*U.*) *hesitata* (Iredale, 1916) widely distributed from South Australia to southern Queensland; and *U.* (*U.*) *capricornica* Lorenz, 1989 and *U.* (*U.*) *petilirostris* sp. nov. from south-central Queensland. Of these, only *U.* (*U.*) *hesitata* is known from the fossil record.

Generic status. There has been considerable debate as to the worth of many of the genera within the family that were erected on the basis of shell morphology, particularly as anatomical studies of several species show that the anatomical features of many of these "genera" are very similar to one another and do not support their separation on shell characters (Kay, 1960). This applies particularly to the Indo-Pacific tropical cowry genera. In the case of *Umbilia*, however, there does seem to be sufficient grounds for recognising the group, either at generic or subgeneric level. These grounds are essentially its unique geological history, its geographic and stratigraphic isolation from other cowry groups, and its paucispiral protoconch. Most of the tropical cowries have pelagic larval stages, which accounts for their widespread distribution. These tropical species have multispiral protoconchs (Ranson, 1967).

Molluses with paucispiral protoconchs usually do not have a pelagic larval stage but hatch directly from the egg as crawling juveniles. Though nothing is known yet of the mode of reproduction of species of *Umbilia*, the distribution and fossil history of the genus also suggest that there was no pelagic larval stage. Ranson (1967) illustrated the protoconchs of specimens of *Umbilia hesitata* and showed these as being paucispiral. Sections made by me of two fossil species, *U.* (*U.*) *angustior* (Pritchard) and *U.* (*U.*) *eximia* (Sowerby) (Figs 1A–B), show that these also have paucispiral protoconchs, so it seems likely that all species of *Umbilia*, living and extinct, feature direct development rather than pelagic larval stages. Wilson (1985) has shown that species of the other endemic genera, *Zoila*, *Austroecypraea* and *Notocypraea*, feature direct development.

Direct development in molluses leads to extensive infraspecific variation (Wilson, 1993). Species of *Umbilia*, both living and fossils show considerable infraspecific variation in shell morphology and colour. This variation has led inevitably to the erection of a considerable number of specific and subspecific names for both colour and morphological varieties which the present work seeks to rectify.

Fossil history. The earliest fossil records of *Umbilia* are from the Late Oligocene, by which time it seems that direct development in the genus had been established. It is suggested here that *Umbilia* may have been derived from an ancestor such as *Palaeocypraea*? *eripnides* sp. nov., from the Paleocene of New Zealand, which has a multispiral protoconch suggesting a pelagic larval stage in its development. Another possible ancestor occurs in the Eocene of Western Australia, *Cypraeorbis* sp., which could have given rise to the Late Oligocene *U. prosila* sp. nov. The fossil record of *Umbilia* shows two possible species lineages, both beginning in the Late Oligocene and continuing through to the Recent: *U. platyrhyncha* – *U. angustior* – *U. eximia* – leading to the living *U. hesitata* and *U. prosila* sp. nov. – *U. leptorhyncha* leading to the the living *U. petilirostris* sp. nov. There are also two other species in the Middle Miocene which on present knowledge do not seem closely related to these lineages and have no known descendants. One of these is sufficiently distinct to justify subgeneric status, *Palliocypraea*. It is possible that the genus *Umbilia* as recognised here is polyphyletic, but until mollecular studies have been undertaken on living representatives, the question must remain unresolved.

Rhynchocypraea Cossmann, 1898 (type species *Cypraea leptorhyncha* McCoy) is synonymised with *Umbilia* (*Umbilia*) in this paper.

Species are described here in groups according to their affinity with one another, and within these groups in stratigraphic order.

Terminology. Measurements in millimetres are given as follows: L, total length of shell; W, width of shell; H, height of shell. Tooth counts are cited as LT, labial teeth and CT, columellar teeth. The terms left and right refer to the animal's true left and right sides respectively.

All material used in this study, unless otherwise stated, is held in the collections of Museum Victoria, registration numbers with prefixes P (Invertebrate Palaeontology collection) and F (living mollusca collection). Localities are cited where possible using the Museum Victoria fossil locality register with prefix PL. The full locality data for these numbers has been published in Darragh (1989, 1991) and Beu and Darragh (2001). Museum acronyms are as follows: BMNH, Natural History Museum, London; TM, Type mollusca collection, New Zealand Institute of Geological and Nuclear Sciences, Wellington; SAM T, Tate Collection, South Australian Museum, Adelaide; AM, Australian Museum, Sydney, New South Wales.

All specimens figured were coated with ammonium chloride for photography, unless stated otherwise.

Class Gastropoda

Cypraeidae

Palaeocypraea Schilder, 1928

Palaeocypraea Schilder, 1928: 17.

Type species. Cypraeacites spirata Schlotheim, 1820 by original designation (Danian, Denmark).

?*Palaeocypraea eripuides* sp. nov.

Figure 2A–D

Cypraea (*Zoila*) n. sp. Beu and Maxwell, 1990: 96, pl. 4j, k.

Type material. Holotype TM8124, paratype TM8125, P.A. Maxwell, 1977.

Type locality. C11/f471, Wave-cut platform below 'The Bluff' homestead, Pitt I., Chatham Is, New Zealand. Pitt I. 713236. Red Bluff Tuff, Late Teurian–late Waipawan, Late Paleocene–Early Eocene.

Occurrence. Type locality only (2 specimens).

Description. Shell of large size for genus, smooth, elongate, pyriform, tapering gently anteriorly. Protoconch multispiral, not distinguished from teleoconch whorls. Spire conical, projecting, covered with thin glaze.

Posterior canal short, inner lip sharp, curved towards and attached to spire. Anterior canal short. Aperture slightly sinuous; outer lip with 12–14 teeth present on anterior two-thirds to half of lip; columella with 8–11 teeth present on anterior two-thirds to half. No terminal ridge. Fossula wide and shallow.

Dimensions	L	W	H	LT	CT
Holotype TM8124	44	22	18	12	8
Paratype TM8125	51	27	27	14	11

Time range. Late Teurian–late Waipawan, Late Paleocene–Early Eocene.

Remarks. Beu and Maxwell (1990) placed this taxon in *Zoila*; however, the fossula is wide and shallow, quite different from the well developed spoon shaped fossula which in all species of *Zoila* is bounded anteriorly by a ridge. Of the Southern Hemisphere cowries, it comes closest to *Umbilia*, but possesses a conical spire and multispiral protoconch in contrast to the umbilicate spire and paucispiral protoconch of *Umbilia*. However, it may well be ancestral to it as discussed below. This species is referred to *Palaeocypraea* with considerable doubt, since the shell is very elongate when compared with other taxa referred to the genus and the fossula is relatively poorly developed, whereas in *Palaeocypraea spirata* the fossula is broad and concave with a distinct notch on the smooth inner border. Owing to the preservation of the specimens, it has not been possible to determine whether this species has fenestrate sculpture on the early whorls of the spire as in other species of the genus.

This is one of the oldest cowries known from the Southern Hemisphere and is included here as a possible ancestor of the southern Australian *Umbilia*, the earliest species of which is known from the Late Oligocene.

Umbilia Jousseaume, 1884

Umbilia Jousseaume, 1884a: 414.—Jousseaume, 1884b: 90; Schilder, 1935: 342.—Schilder, 1939: 186.—Wenz, 1941: 995.

Type species. Cypraea umbilicata Sowerby, 1825 (*non* Dillwyn, 1823 = *C. hesitata* Iredale, 1916) by monotypy. Recent, south-eastern Australia.

Diagnosis. Shell highly glazed, of medium to large size for the family, pyriform with umbilicate

spire. Anteriorly and posteriorly rostrate, the anterior rostrum generally larger and bearing 2 dorsal tubereles. Rostra supported by flanges that may be weakly or strongly developed or extend around the base of the last whorl. Aperture sinuous with weakly or strongly developed teeth. Fossula weakly developed or absent.

Remarks. The monotypie subgenus *Palliocypraea* from the Mioeene is eharaeterised by the development of a thin, wide, flat flange extending around the base. Speeies of *Umbilia* laeking this feature are all plaeed in the subgenus *Umbilia* sensu strieto.

Umbilia (*Umbilia*) Jousseaume, 1884

Umbilia Jousseaume, 1884a: 414.—Jousseaume, 1884b: 90.—Schilder, 1926: 378.—Thiele, 1929: 275.—Schilder and Schilder, 1939: 145.

Cypraea (*Umbilia*).—Harris, 1897: 209.—Cossmann, 1903: 160.—Wilson, 1993: 191.

Rhynchocypraea Cossmann, 1898: 17, type speeies (original designation) *Cypraea* (*Luponia*) *leptorhyncha* MeCoy, 1877.—Wenz, 1941: 994.

Rhynchocypraea.—Cossmann, 1903: 174, in part; not of Cossmann, 1898.

Umbilia (*Umbilia*).—Schilder, 1935: 342.—Schilder, 1939: 186.—Wenz, 1941: 995.

Umbilia (*Rhynchocypraea*).—Schilder, 1935: 342.—Schilder, 1939: 186.

Diagnosis. Shell solid, highly glazed, of medium to large size for the family, elongate to subglobosely pyriform, generally somewhat more ventrieose posteriorly. Anteriorly and posteriorly rostrate; anterior rostrum elongate to very elongate in some speeies, flattened ventrally, bearing 2 weakly to well developed dorsal tubereles separated by sinuous groove. Posterior rostrum deeply notehed. Rostra supported by triangular extensions of base (extensions poorly developed on speeies with short rostra). Anterior and posterior eanals ineised into anterior and posterior rostra. Dorsal surface of shell generally smooth, somewhat granular on some speeimens.

Spire depressed below last whorl, early teleoeoneh and protoeoneh eovered with thin glaze, in most speeies spire whorls and protoeoneh visible on slightly deeortieated speeimens. Protoeoneh of 3 or 4 smooth dome-shaped whorls, tilted at about 10° to axis of teleoeoneh. Teleoeoneh of 3–4 whorls.

Aperture sinuous. Labial teeth well to poorly developed, on some speeimens eovering whole length of lip, on others fading on posterior half; eolumella teeth variable in expression, on one speeies developed into a series of prominent elongate ridges separated by deep grooves; teeth and ridges variable in number, on some speeies fading on posterior half of columella. Terminal ridges of aperture, variable in strength and number, from one to three. Fossula on most speeies weakly developed, absent on some speeimens.

Time range. Janjukian (Late Oligoeene) to Reeent.

Distribution. Southern Western Australia (Plioeene, Reeent); South Australia (Middle Mioeene–Late Mioeene, Reeent); Vietoria (Late Oligoeene–Late Mioeene, Reeent); Tasmania (Early Mioeene, Late Plioeene, Recent); New South Wales (Reeent); southern Queensland (Recent).

Remarks. The well developed anterior rostrum is the most eharaeteristie feature of this subgenus. The posterior rostrum is generally much less developed and varies between speeies from being greatly extended to a short stump.

Cossmann erected *Rhynchocypraea* in 1898, with type speeies, *Cypraea* (*Lnponia*) *leptorhyncha* MeCoy for Australian fossil speeies having rostral extensions of the aperture. In 1903, he either overlooked or ignored his previous designation and eited *C. loxorhyncha* Tate (an error for *toxorhyncha*) as type speeies instead. He plaeed *C. leptorhyncha* in his newly erected *Austrocypraea* (type speeies *C. contusa* MeCoy). *C. toxorhyncha* is a junior synonym of *Zoila platypyga* (MeCoy). Vredenberg (1927) aeeepted Cossmann's 1903 interpretation, unaware of Cossmann's original designation of a type species for *Rhynchocypraea* but synonymised both *Umbilia* and *Rhynchocypraea* with *Gisortia* from the *Paleogene* of Europe.

In 1930, Schilder regarded *C. leptorhyncha* as an *Umbilia*, stating that numerous identieal speeimens seemed to exelude their being juveniles of *U. eximia* and that the speeies eonnected the rostrate *Umbilia* with *Austrocypraea pyrulata* (Tate). In 1935, however, Schilder maintained *Rhynchocypraea* as a subgenus of *Umbilia*, stating that it was related to *Umbilia* (*Palliocypraea*) and also that it was elosely related to some speeies of his new genus, *Notolnponia*, (presumably *pyrulata*). Schilder separated *Rhynchocypraea* from *Umbilia* by the presenee of a shallow rather than deeply notched posterior outlet and by the fact that it was not rostrate. In 1939, Schilder stated that *Rhynchocypraea* was more pear shaped, more gibbous, with a more slender anterior end, wider mouth and narrower siphonal canal. These differences are quite insignifieant, *leptorhyncha*

is just as anteriorly rostrate as *hesitata*, if not more so and the posterior outlet and width of aperture and canals vary in degree of development from species to species. As I can find no consistent character which can justify separation of *leptorhyncha* from *hesitata* at the generic level, I regard *Rhynchocypraea* as a synonym of *Umbilia* (*Umbilia*).

Wilson (1993) suggested that *Umbilia* (*U.*) *hesitata* fed on bryozoans. Bryozoans are a common element in the fossil assemblages of the formations in which fossil species of *Umbilia* have been found. Lorenz (1988) reported finding the remains of sponges in the stomachs of specimens of *U.* (*U.*) *capricornica* and Wilson (1998) reported divers taking *U.* (*U.*) *armeniaca* crawling on sponges. Species of *Zoila* are known to feed on sponges (Wilson and McComb, 1967). The anatomy of only one living species of *Umbilia* is known. Lorenz (1988) briefly described and illustrated the broad features of *U. capricornica*, comparing it to *Cypraeovula fuscorubra* and *Cypraea cruikshanki* from southern Africa. Judging from Lorenz's figures the anatomy of *U. capricornica* is somewhat similar to that of *Zoila friendii* described and illustrated by Wilson and McComb (1967), particularly in the presence of a bursa copulatrix in the female genital system.

The origin of the genus is not known. There is nothing quite like it known from the Southern Hemisphere, except possibly *?Palaeocypraea eripnides* sp. nov., Late Paleocene–Early Eocene, Chatham Islands, New Zealand and an undescribed species of *Cypraeorbis* from the Late Eocene of Western Australia. The New Zealand species seems to have a multispiral protoconch, as in other species of *Palaeocypraea*, suggesting a planktonic larval stage, whereas species of *Umbilia* have paucispiral protoconchs more consistant with direct development. If *Umbilia* is descended from this or some similar taxon, there is adequate time between the Palaeocene and Late Oligocene for a switch to direct development to have taken place. Other changes would involve an elongation of the anterior canal. Otherwise the overall morphology of *?Palaeocypraea eripnides* sp. nov. is not dissimilar from that of small specimens of the Late Oligocene, *Umbilia platyrhyncha*, and from specimens of the Early Miocene, *U. angustior*. In contrast to this suggestion, the Western Australian species of *Cypraeorbis* is closer to the Late Oligocene *U. prosila* sp. nov. in overall shell shape but has a much shorter anterior canal and deeper fossula.

Umbilia* (*Umbilia*) *platyrhyncha (McCoy, 1876)

Figures 2E–F, H–K; 3A–F

Cypraea (Aricia) platyrhyncha McCoy, 1876: 40: 30, figs 2–2c.

Umbilia (Umbilia) platyrhyncha.—Schilder, 1935: 343.

Type and figured material. Holotype P12138.

Figured specimens. P59169, Richard Daintree, Geological Survey of Victoria, Jul–Aug 1861. P302697, C.W. Mallett, 15 Oct 1972. P302784, G.B. Pritchard Collection.

Type locality. Geological Survey of Victoria locality Ad24 (PL3024 Cliff section opposite Bird Rock, below Bird Rock cap, Torquay, Victoria, Torquay 6425l8). Jan Juc Formation, Late Oligocene, Janjukian.

Occurrence and material. Type locality only (17 specimens).

Description. Shell of medium size for genus, pyriform, maximum convexity close to posterior, tapering anteriorly and produced into broad, flattened rostrum with 2 weak dorsal tubercles present on some specimens. Transverse section of last whorl subcircular. Spire barely if at all visible, on most specimens covered with thick glaze. Protoconch of 4 smooth dome-shaped whorls, tilted at about 10° to axis of teleoconch whorls.

Posterior canal very short, twisted dorsally toward spire; margins thickened, outer margin more so and produced beyond inner margin. Anterior canal elongate, deeply incised into rostrum. Aperture only very slightly sinuous; outer lip with 15–20 teeth present on about half lip to midpoint of aperture. Columella with about 12 weak teeth, fading in strength posteriorly; slight trace of ridge extending from posterior teeth along columella to left side of posterior canal. Terminal ridge absent. Fossula broad, very gently concave, merging imperceptibly into columella margin. Dorsal surface smooth, shining.

Dimensions	L	W	H	LT	CT
Holotype P12138	95	46	38	12	15
Figured specimen P302697	79	37	33	15	8
Figured specimen P302784	86	39	33	13	12
				very faint	
Figured specimen P59169	40	32	12+	20+	87

Time range. Janjukian, Late Oligocene.

Remarks. This is the one of the two oldest known species of the genus recorded, and the rarest of the fossil species. Most specimens are slightly decorticated, slightly distorted, or broken. The

species is characterised by weakly developed teeth, an elongate shape, lack of an umbilicus, concealed spire, weakly developed dorsal tubercles and massive flat anterior rostrum and heavy posterior canal.

This species bears some resemblance to ?*Palaeocypraea eripnides* sp. nov., Pitt L., New Zealand (Fig. 2A–D), but it is much more massive, about twice the size, has a relatively longer anterior rostrum and a paucispiral rather than a multispiral protoconch. *P. eripnides* has slightly stronger developed teeth that extend almost to the end of the anterior canal. The fossulae of both are similar. *P. eripnides* has a prominent conical exert spire, whereas the spire in *Umbilia* (*U.*) *platyrhyncha* is depressed and covered with a thick callus deposit.

Umbilia (*Umbilia*) *angustior* (Pritchard, 1896)

Figures 1A; 2G; 3G–I; 4A–I

Cypraea platyrhyncha angustior Pritchard, 1896: 107: 4, figs 8, 9;

Umbilia (Umbilia) platyrhyncha angustior.—Schilder, 1935: 343.

Umbilia sp.—Burgess, 1989: 11, fig D.—Lorenz, 1989: fig. 5.

Type and figured material. Holotype P2671, E.D. Atkinson Collection.

Figured specimens. P302785, F.A. Cudmore Collection. P302688, T.A. Darragh, 15 Nov 1984. P302703, T.A. Darragh 30 Nov 1972.

Type locality. Table Cape. The matrix indicates that the holotype came from the lower bed, i.e. PL3028 Lower bed in cliff between Fossil Bluff and 1.5 km NW towards Table Cape, Wynyard, Tasmania, Table Cape 930630. Freestone Cove Sandstone, Early Miocene, early Longfordian.

Occurrence and material. Freestone Cove Sandstone: PL3028 Lower bed, Table Cape (25 specimens). Fossil Bluff Sandstone: PL3029 Upper bed, Table Cape (5). Puebla Formation: PL3032 Jan Jue Beach (2). Fishing Point Marl: PL3037 Camping Reserve, Hordern Vale (2); "Picnic bed", Red Hill district, Hordern Vale (2); Fishers Point, Hordern Vale (2); Cutting on road to Hordern Vale camping reserve (1).Gellibrand Formation: PL3033 Birregurra (2).

Description. Shell of small size for genus, pyriform, maximum convexity close to posterior, tapering rapidly to anterior, produced into a rapidly narrowing rostrum bearing 2 low tubercles. Transverse section of last whorl subcircular. Spire covered with thick glaze, slight trace of umbilicus on some specimens. Posterior canal relatively short, twisted back dorsally towards spire, margins produced, thin. Anterior canal long, deeply immersed in rostrum.

Aperture somewhat sinuous, outer lip with 8–22 teeth, on most specimens fading about midpoint of aperture, inner lip with 8–20 teeth on most specimens, fading about midpoint of aperture; slight trace of ridge extending from teeth to side of posterior canal margin. Terminal ridge absent. Fossula narrow, flattened, merging imperceptibly into columella. Dorsal surface smooth.

Dimensions	L	W	H	LT	CT
Holotype P2671	68	34	27	13	16
Figured specimen P302785	71	33	26	9	13
Figured specimen P302688	67	37	32	12	24 PL3032
Figured specimen P302703	56	28	23	23	27 PL3037

Time range. Longfordian, Early Miocene.

Remarks. As pointed out by Pritchard (1896), this species differs from *Umbilia* (*U.*) *platyrhyncha* (McCoy) by its smaller size, more rapidly tapering anterior rostrum, more strongly developed dorsal tubercles and the relatively thin sides of the posterior canal. Although Pritchard considered *angustior* merely to be a variety of *U.* (*U.*) *platyrhyncha*, the material before me, though showing some variation, does not in fact overlap in morphology with the latter and therefore I accept *angustior* as a full species. It seems most likely to have evolved from *U.* (*U.*) *platyrhyncha* and to have probably given rise to *U.* (*U.*) *eximia*. Some specimens are rather tumid, approaching *U.* (*U.*) *eximia* in whorl shape (Figs 2G-H), but lacking the prominent rostra of *U.* (*U.*) *eximia*.

Umbilia (*Umbilia*) *eximia* (G.B. Sowerby I, 1845)

Figures 1B; 5A–H; 6A–H; 7B–I; 8A–H

Cypraea eximia G.B. Sowerby I, 1845: 296, pl. 19 figs 1–3.—Tate, 1890: 209.

Cypraea (Aricia) eximia.—McCoy, 1876: 35, pls. 27–28 figs 2–2b. All figures reversed in lithographing.

Cypraea (Aricia) eximia var. *brevis* McCoy, 1876: 36.

Cypraea sphaerodoma Tate, 1890: 209.—Tate, 1892: pl. 8 fig. 5.—Harris: 1897: 211.

Cypraea (Umbilia) eximia.—Harris, 1897: 210.

Rhynchocypraea eximia.—Cossmann, 1903: pl. 6 fig. 11.

Rhynchocypraea loxorhyncha Tate.—Cossmann, 1903: pl. 8 fig. 5 (error for *toxorhyncha*) not *toxorhyncha* of Tate, 1890.

Gisortia eximia.—Vredenburg, 1927: 50, pl. 3 fig. 5 (copy of Cossmann, 1903: pl. 6 fig. 11).

Umbilia (Umbilia) eximia maccoyi Schilder, 1932: 183.—Schilder, 1935: 344.

Umbilia (Umbilia) montis-marthae Schilder, 1935: 344, fig. 29.

Umbilia (Umbilia) brevis brevis.—Schilder, 1935: 344.

Umbilia (Umbilia) brevis frankstonensis Schilder, 1935: 344.

Umbilia (Umbilia) eximia eximia.—Schilder, 1935: 345.

Umbilia sphaerodoma (Tate).—Lorenz, 1989, fig. 5.

Type and figured material. Holotype BMNH G9694, P.E. Strzelecki Collection. The specimen bears a paper label inside the shell bearing the number 215.

Syntypes of *Cypraea (Aricia) eximia* var. *brevis* NMV P5296, Geological Survey of Victoria, Geological Survey of Victoria locality Aw 9, 3 miles W of the mouth of the Gellibrand River; NMV P12136, Geological Survey of Victoria, between Mount Eliza and Mount Martha. The colour and preservation of P12136 suggests that the specimen probably came from the Fyansford Formation at Fossil Beach, Balcombe Bay. This specimen is chosen as lectotype of *brevis*.

Holotype of *Umbilia (U.) brevis frankstonensis* BMNH G40069, E.O Teale Collection presented Jan 1926. This specimen is labelled 'Grices Creek, Frankston, Mornington' on a printed label. Another handwritten label bears the locality 'Mornington'. The light colour of the specimen and matrix (Fyansford Formation) suggest that Grices Creek is correct.

Holotype of *U. (U.) brevis montismarthae* BMNH 70406, purchased Bryce M. Wright, 90 Great Russell St., London. This specimen bears a printed dealer's label with the handwritten number 17 and locality 'Mount Martha, Victoria'. This specimen is abraded and has fragments of hard dried clay inside the aperture. It is typical in matrix, colour and condition of those specimens washed out from the clay (Fyansford Formation) and picked up on the surface at Fossil Beach, S of Mornington.

Syntypes of *Umbilia (U.) eximia maccoyi* NMV P12135 (McCoy, 1876, figs 2, 2b), P16171 (McCoy, 1876, fig. 2a) Geological Survey of Victoria, between Mount Eliza and Mount Martha. The original labels with these specimens are missing. The original drawings for McCoy's plate were undertaken by Arthur Bartholomew in Jun and Jul 1861, which indicates that the specimens were collected before then and so almost certainly by Alfred Selwyn during his survey of the Mornington Peninsula in 1854. The complete specimen, P12135, is chosen as lectotype of *Umbilia (U.) eximia maccoyi*. The colour of the matrix, light grey, and the light colour of the shells suggest that they were collected from outcrops of the Fyansford Formation at Grices Creek or nearby Manyung Rocks.

Lectotype of *Cypraea sphaerodoma* Tate SAM T821, R. Tate Collection, 'Eocene, River Murray Cliffs, near Morgan' i.e., PL 3084 Small gully 4.8 km S of Morgan Ferry–Cadell road on left bank of Murray River opposite Brenda Park Homestead, South Australia. Morgan 790280. Morgan Limestone, Cadell Marl Lens, Middle Miocene, Balcombian. This is the original of Tate, 1892, pl 8 fig. 5, which is chosen as lectotype.

Figured specimens. P302779, F.A. Cudmore Collection. P302712, E.D. Gill, 27 Apr 1956. P302716, presented H.J. Hauschildt, 30 Jul 1906. P302782, T.A. Darragh, 4 May 1996.

Type locality. The holotype described by Sowerby was obtained by P.E. Strezelecki during his visit to Australia in 1839–1843. According to the original description given in Strzelecki (1845), the holotype was 'Found in a muddy sand, in sinking a well to 140 feet in depth, at Franklin's Village, Van Diemen's Land, about 15 miles from the sea'. There are two Franklin's Villages in Tasmania. The better known of the two is now an outer suburb of Launceston on the Hobart Road about 5 km south of the centre of the city and thus nowhere near '15 miles from the sea'. It is situated in the Tamar Graben which is filled with non-marine sediments. The possibility that the specimen could have come from here is considered to be so remote as to be virtually impossible. The other place bearing this name is on the coast at the west end of Cape Barren I. in the Furneaux Group, Bass Strait. At this locality, which I visited in February 1969, there is a thin sequence of Tertiary bryozoal calcarenite sitting on granite within a kilometre of the sea. Again it is most unlikely that the specimen could have come from here, though Strzelecki is known to have visited the Furneaux Group. This species has never been recorded from Tasmania, only from South Australia and Victoria. Strzelecki (1845) does not mention this fossil in his book at all, whereas virtually all the other fossils described by Lonsdale, Morris and Sowerby are mentioned either in Strzelecki's discussion of the geology of the country or under fossil fauna, in some cases in both places. The two species of land snail, *Bulimus gunni* and *Helix tasmaniensis*, illustrated on the same plate as *Cypraea eximia* are mentioned by Strzelecki twice, but neither *C. eximia* nor *Terebratula compta*, a brachiopod from Port Fairy, Victoria, also figured on the plate, are mentioned at all. Strzelecki does not even record the genus *Cypraea* anywhere in the book, though he mentions other genera of gastropods as occurring in the Tertiary of Tasmania. This suggests that there is an error in the locality.

There is some matrix still adhering to the specimen and also present inside the shell. The specimen is light in colour with traces of yellow grey silt adhering to it. Inside the shell were some polished shell fragments as well as pieces of the grey silt. Of the Victorian occurrences of the species, the area which contains sediments which best matches the matrix is Geelong. The Fyansford Formation in the Geelong district, for example at Red Hill, Shelford, is slightly weathered to a yellow grey colour and has similar texture to that in and on the type specimen. It is also pertinent to note that some specimens from the Fyansford Formation around Geelong seem to have the posterior canal twisted to the right almost as in the holotype, a feature not so common in specimens from other areas.

Strzelecki was in Melbourne and could have received the specimen there or even in Tasmania, because many

of the Port Phillip settlers came from Tasmania and travelled back and forth. Sowerby described *Terebratula compta* from Port Fairy, Victoria, following his description of *Cypraea eximia* which shows that Strzelecki did have access to Victorian specimens, even though he did not travel to Geelong or Port Fairy.

The weight of the evidence, though circumstantial, seems to indicate that the true type locality was in Victoria, probably some source within the Fyansford Formation in the Port Phillip Embayment of the Otway Basin.

Occurrence and material. Batesfordian. Fishing Point Marl: Fishing (= Fishers) Point, Hordern Vale (1 fragment). Gellibrand Formation: PL3043 Kennedy Creek cutting (2 specimens). Wuk Wuk Marl: PL3054 Skinners (1 fragmentary specimen).

Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (27 specimens); Muddy Creek, Hamilton (24); Miocene, Hamilton (2); Grange Burn Gorge 3. Fyansford Formation: PL3069 Red Hill, Shelford (5); PL3071W of Glen Leigh (1); PL3072 Fyansford (5); PL3077 Altona Bay Coalhaft (4 and 3 fragments); PL3074 Dingleyhaft (2 and 3 fragments; PL3078 Fossil Beach, Balcombe Bay (35); PL3079 lower beds, Grices Creek (5); Old Quarries, Batesford (2); Overburden, Batesford Limestone Quarry (5); Native Hut Creek (upper) (1); Mornington (6); south-eastern trunk sewer spoil dump, Carrum (2); Braeside Tunnel spoil (1); Shelford (3). Cadell Marl: River Murray cliffs, 4 miles south of Morgan (1 and 2 fragments). Morgan Limestone: Broken Cliffs opposite Waikerie, River Murray, South Australia (selenite replacement, AM P29732).

Bairnsdalian. Gellibrand Formation: PL3087 Lake Bullenmerri (3 and 3 fragments); Lake Gnotuk (1); PL3088 east of Glenample Steps (2); Cowleys Creek (1); Between Gibsons Beach and Point Ronald (10). Rutledges Creek Member of Port Campbell Limestone: PL3093 Rutledges Beach (1). Fyansford Formation: PL3098 Native Hut Creek (3 fragmentary); PL3100 Murgheboluc 4A (7); PL3102 Warrambine Creek (2); PL3103 downstream Grices Creek (1); PL3104 Manyung Rocks (15); Grices Creek (36); Leigh River at Shelford (1); Inverleigh (1 and 1 fragment); Mount Eliza (1); Mouth of Grices Creek (1). Bookpurnong Beds: PL3298 Wookool (3 and 2 fragments).

Description. Shell globosely pyriform, with maximum convexity about two-thirds length of shell from anterior end; tapering rapidly anteriorly to form long narrow, rounded anterior rostrum; rostrum supported by 2 strong lateral elongate subtriangular extensions of base and bearing 2 prominent dorsal tubercles. Transverse section of last whorl subcircular. Spire covered with thin glaze, all whorls visible.

Posterior canal long to short, posterior end slightly reflexed dorsally, twisted to left or right, on most specimens to left; canal supported by short flattened triangular extensions of base. Anterior canal elongate, embraced by rostrum. Aperture sinuous, outer lip with 23–40 teeth, on most specimens present along entire length, on some specimens fading at posterior third; columella bearing 23–37 prominent teeth, extending along length of aperture, on some specimens very short, on most, extended into long ridges across base away from aperture, sometimes bifurcating; teeth encroaching on fossula on many specimens. Fossula very narrow if at all present.

Dorsal surface on most specimens smooth, shining, showing traces of mantle edges running as shallow sulcus from end of posterior canal across left side of spire umbilicus across dorsum between dorsal tubercles and onto anterior rostrum; some specimens with very shallow depressions over shell.

Dimensions	L	W	H	LT	CT
Holotype BMNH G9694	82	40	31	34	34
BMNH G40069	99	51	43	31	23
BMNH 70406	70	43	36	32	29
P5296	77	42	34	37	25
P12136	82	43	36	29	23
SAM T821	84	49	39	29	25
P12135	103	51	42	38	25
P16171	99	47	39	34	30
Figured specimen P302779	87	43	34	23	24 PL3079
Figured specimen P302712	69	37	31	30	25 PL3087
Figured specimen P302716	76	49	32		crushed, Rose Hill
Figured specimen P302682	89	44	33	26	20 PL3298

Time range. Batesfordian–Bairnsdalian, Early Miocene–Middle Miocene.

Remarks. This species was the first Tertiary mollusc to be described from Australia. It is the most common species of the larger cowries and one of the most highly variable in morphology. The variation is random through time and across the geographic distribution of the species. This variability was not taken into account either by Tate, or Schilder in particular, when erecting new taxa, so that it probably has more synonyms than any other Australian Tertiary mollusc. McCoy remarked how variable the species was in the degree of development of the anterior canal and erected a variety *brevis* based on two small specimens with particularly short canals but without illustrating them. This name was elevated to the status of species by Schilder (1935), who did not see the specimens. There is every variation in size

of specimens and degree of development of the canals in the one population from Grices Creek and from other localities, e.g., Muddy Creek, consequently *brevis* is not recognised here as a valid taxon.

Tate distinguished his species *Cypraea sphaerodoma* from *C. eximia* by its globose body whorl, the abrupt sinistral curvature of the posterior half of the aperture, and the strong torsion of the posterior canal. Specimens of similar shape can be found intergrading with other forms in populations from Fossil Beach (Fyansford Formation) and Muddy Creek (Muddy Creek Formation), so that this name may be regarded as a synonym of *Umbilia eximia*.

The holotype of *U. eximia*, which matches most other specimens in its general morphology, has the distal end of the posterior canal twisted prominently to the left when viewed from the dorsal side, whereas most other specimens have a posterior canal which is straight or has the distal end twisted slightly to the right. However, there are all variations between the condition shown by the holotype and that shown by the specimens figured by McCoy (1876), in which the canal is bent slightly to the right in dorsal view. This feature was used by Schilder (1932) to differentiate between *U.* (*U.*) *eximia* and his new species, *U.* (*U.*) *eximia maccoyi* (based on McCoy's figured specimens), but given the variability in populations, the distinction cannot be sustained and *maccoyi* is also placed in synonymy with *U.* (*U.*) *eximia*.

Other features used by Schilder in differentiating his other new taxa, *U.* (*U.*) *brevis frankstonensis* and *U.* (*U.*) *brevis montismarthae*, are also variable. The columellar teeth, which are produced into prominent ridges extending across the base in the holotype and most other specimens, can be considerably reduced to ridges extending across half the base or merely to the edge of the columella. These ridges commonly extend onto the fossula, such as it is; that is, they commonly extend well into the aperture. The dorsal tubercles are strongly developed in most specimens, but can be quite weak in others from the same population. The holotype of *U.* (*U.*) *brevis montismarthae* is water-worn, with extremities that are broken and not 'extremely short' as maintained by Schilder. The sulcus connecting the spire and dorsal side of the posterior canal, cited as a differentiating feature of *montismarthae*, is present to a greater or lesser extent on all specimens examined, including the lectotype of *U.* (*U.*) *brevis brevis*. The dorsal tubercles present on the holotype of *U.* (*U.*) *brevis frankstonensis* are no weaker than those found on other specimens with prominent ridgelike teeth from the same locality. There are all degrees of variation in specimens from Grices Creek. For these reasons, both Schilder's names are also placed in synonymy with *Umbilia eximia*.

Only two undoubted specimens of *U.* (*U.*) *eximia* are known from the Gippsland Basin, though internal moulds probably of this species are common in the Bairnsdale Limestone. The two specimens come from PL3054, Skinners, on the Mitchell River (Batesfordian) and Rose Hill (no other locality data), near Bairnsdale. The Rose Hill specimen (Fig. 7F–G) does not have matrix typical of the Tambo River Formation at that locality and may have come from the top of the underlying Bairnsdale Limestone. Specimens of *U.* (*U.*) *hesitata* occur in the Tambo River Formation at Rose Hill, so if the Rose Hill specimen of *U.* (*U.*) *eximia* does come from there, it would make an ancestor/descendent relationship between these two species unlikely. Both *U.* (*U.*) *hesitata* and *U.* (*U.*) *eximia* also occurr in the Bookpurnong Beds at Loxton, though as yet not recorded from the same localities within the formation.

Umbilia (*Umbilia*) *hesitata* (Iredale, 1916)

Figures 7A; 9A–H; 10A–I; 11A–H; 12A, C, F–H; 13D–E; 14A–C; 19C

Cypraea umbilicata Sowerby, 1825, appendix: xxx, pl. non Dilwyn, 1823.—Beddome, 1898: 564 (with discussion on early literature).—Verco, 1912: 211 (with synonymy).

? *Cypraea amygdalina* Tate, 1890: 209.—Tate, 1892, pl. 6, fig. 8, non Grateloup, 1847.

? *Cypraea tatei* Cossmann, 1903: 160, pl. 7 figs 4, 6, nomen novum for *Cypraea amygdalina* Tate, 1890.

Cypraea hesitata Iredale, 1916: 93, nomen novum for *Cypraea umbilicata* Sowerby, 1825.

Umbilia hesitata beddomei Schilder, 1930: 77.

Umbilia hesitata howelli Iredale, 1931: 220–224, figs 1–2.

Umbilia cera Cotton, 1947: 667, pl. 21, figs 1–3.—Ludbrook, 1958: 45.

Cypraea tatei Cossmann.—Ludbrook, 1973, pl. 27 figs 87–88.

Cypraea (Umbilia) hesitata.—Wilson, 1993: 192, pl. 30 figs 7, 9–11.

Type and figured material. Lectotype BMNH 1950.8.28.22, Broderip Collection (Sowerby's figured specimen chosen as lectotype here).

Holotype of *U. cera* Cotton, SAM P8339, donated H.S. Pratt, 1925.

Syntypes of *Cypraea amygdalina* Tate (= *tatei*

Cossmann), SAM T812A, B, Ralph Tate Collection. T812A Tate's figured specimen chosen as lectotype here. Matrix associated with the two specimens is a carbonate rich glauconitic sand. The type locality cited was a well sinking in the Murray Desert. Tate had material from wells at Tareena in southwestern New South Wales and Mindarie in South Australia and it is not known from which place the type specimens came, since Tate (1899: 104) recorded his species from both. Whatever the origin, the shells seem to have come from the Bookpurnong Beds.

Holotype of *Umbilia hesitata beddomei* Schilder, 1930, Schilder collection no. 821, Zoologisches Institut, Humboldt Museum, Berlin (locality unkown), purchased Fulton.

Holotype of *Umbilia hesitata howelli* Iredale, 1931, AM C57762.

Figured specimens. P302717– P302718, John Dennant Collection. Figured specimen P302720, G.B. Pritchard Collection. P302780, collected and presented J.M. Warren. P302770, T.A. Darragh, D.M. Shanks and H.E. Wilkinson, 8 Feb 1969. P302781, T.A. Darragh, D.M. Shanks and H.E. Wilkinson, 11 Feb 1969. F4526, J.H. Macpherson, 6-11 Jun 1948. F23166, presented T.A. Garrard. Figured specimens WAM 89.636a–b, G.W. Kendrick, 27–30 Oct 1988. Geological Survey of South Australia M1335, M.J. Paul (figured Ludbrook, 1973).

Occurrence and material. Bairnsdalian. ? Dry Creek Sands: Abattoirs Bore (fragmentary specimens). Bookpurnong Beds: 1.5–3 m below bed of River Murray, Loxton, South Australia.

Mitchellian. Tambo River Formation: Rose Hill Farm near Bairnsdale (2 specimens).

Cheltenhamian. Black Rock Sandstone: Beaumaris (3). Jemmys Point Formation: PL3115 Lake Bunga Crossing (2 fragmentary specimens); PL3123 Ferndale Parade (2 fragmentary specimens).

Pliocene. Jemmys Point Formation: PL3275 Gosnells Point (1 specimen). Cameron Inlet Formation: PL1250 (2), PL1258 (3), PL1261 (1), PL1264 (17), PL1265 (2), PL1287 (2), PL1296 (1). West end of North Memana Drain, Memana, Flinders I. (3); Flinders I. (1); South side of Nelson Lagoon Drain, Flinders I. 018588 (1); Land Settlement Division Drain, Flinders I. (3). Roe Calcarenite: PL3166 2.5 km N Hampton Tower (4), PL3165 16 km S of Madura (1), Pl3167 1.5 km N Hampton Tower (1), PL3172 Hampton Tower (2).

Records of living species are from north-east of Cape Morton, Queensland to Robe, South Australia, including northern and western Tasmania as far south as Port Davey, 70–400 m. Pliocene records from the Roe Calcarenite lie outside of the recorded modern distribution.

Description. Shell of small to average size for genus, highly glazed, subpyriform, tapering gently anteriorly and produced into short rounded rostrum bearing traces of 2 dorsal tubercles, slightly rostrate posteriorly. Spire umbilicate, covered with glaze, about 5 whorls visible.

Posterior canal very short, margins thickened, twisted to left in ventral view. Anterior canal short, embraced by rostrum, supported by very weak lateral flanges. Aperture sinuous, outer lip with 30–40 teeth; inner lip with 28–37 teeth which become slightly weaker on posterior half of columella. Fossula very narrow, very slightly depressed. On some specimens slight trace of sulcus running from left side of posterior canal across dorsum onto anterior rostrum between tubercles.

Colour white with irregular sized brown spots over dorsum and large brown patches on anterior rostrum and on most specimens on either side of posterior canal; ventral surface white. Some specimens almost entirely white.

Time range. Bairnsdalian?, Mitchellian-Recent, Middle Mioecne?, Late Mioecne–Recent.

Remarks. This species may be descended from *Umbilia* (*U.*) *eximia* but, as noted above, there could be an overlap in the time ranges of the two species in the Middle to Late Mioecne. *U.* (*U.*)

Dimensions	L	W	H	LT	CT	
Lectotype BMNH 1950.8.28.22	96	58	–	33	31	
Figured specimen P302781	88	51	42	31	27	
Figured specimen P302780	85	45	35	32	31	
Figured specimen P302770	62	38	30	28	28	off Botany Bay
Figured specimen F4526	103	58	48	34	35	
Figured specimen F23116	65	41	41	29	25	*beddomei* form
AM C57762	111	64	53	38	31	holotype of *U. howelli* Iredale.
SAM P8339	55	36	29	26	22	holotype of *U. cera* Cotton
Figured specimen SAM T812A	56	37	29	22	29	leetotype of *Cypraea tatei* Cossmann.
Figured specimen P302717	86	49	40	–	30	
Figured specimen P302718	55	36	26	24	22	
Figured specimen P302720	62	36	29	29	23	
Figured specimen WAM 89.636a	83	50	40	33	30	
Figured specimen WAM 89.636b	87	53	42	36	30	

hesitata differs from *U.* (*U.*) *eximia* in having less prominent columellar teeth and a less prominent anterior rostrum and posterior canal. The dorsal tubercles on the anterior rostrum are also weakly developed and the lateral flanges supporting the rostrum are obsolete in *U. hesitata*. The differences between *U. hesitata* and the other southern Australian living species, *U. armeniaca*, are not great. *U. hesitata* tends to be slightly less tumid than *U. armeniaca* and has a slightly longer anterior rostrum. On our present knowledge of the distributions of both taxa, there is a considerable gap between the range extremities of both species.

The type specimens of both *Cypraea tatei* Cossmann (probably Bookpurnong Beds at Tareena or Mindarie) and *Umbilia cera* Cotton (Dry Creek Sands) are both small and fragmentary. They seem to be similar if not identical to small specimens of *U. hesitata*, but until a range of material from the Bookpurnong Beds and Dry Creek Sands is available, it is not possible to be certain of the identity of *Cypraea tatei* in particular, since the apertures on the specimens look immature. For this reason I have included the name with a query in the synonymy above, at the same time preserving the stability of the name of the well known common living species, *Umbilia hesitata*. Since both *tatei* and *cera* seem to come from Middle Miocene strata, there is also a possibility that they are small specimens of *U. eximia*. This seems unlikely, but the anterior rostra on all specimens are broken, so there is doubt about their identity.

Late Miocene and Early Pliocene specimens of *U. hesitata* are not common and most are fragmentary or poorly preserved; however, there is sufficient well preserved material available to be confident of the identification.

Umbilia hesitata beddomei was based on a small form, with somewhat brighter coloured dorsum, base with less callus and whiter. The holotype is from an unknown locality (Dr Matthias Glaubrecht pers. comm. January 2000), but Schilder cited Port Stephens, New South Wales as a locality based on Beddome's (1898) description and figure of a similar specimen. Such small specimens (Figs 12A, C) are found throughout the geographic range of the species as well as in the fossil record (Figs 9G–H, 10A–C) and intergrade with larger specimens from the same locality. For these reasons *Umbilia hesitata beddomei* is regarded as a synonym of *hesitata* and cannot be accepted as a geographic subspecies.

Umbilia hesitata howelli was erected by Iredale (1931) as a new subspecies ((type locality 164–274 m, off Cape Everard (Point Hicks), Bass Strait, Victoria) for a large, pure white variety previously called variety *alba* Cox, 1879 (non Blainville, 1826, nec Sowerby, 1832). Apart from its colour, it cannot be distinguished from other specimens of *hesitata* and is regarded as a mere colour form and therefore synonymised.

Umbilia* (*Umbilia*) *prosila sp. nov.

Figures 15A–C, E, H

Type material. Holotype P308716, Paratype P308717, F.A. Cudmore collection.

Type locality. Ledge, Bird Rock Cliffs, Torquay, Victoria. Jan Juc Formation, Janjukian, Late Oligocene.

Occurrence and material. Jan Juc Formation. Ledge, Bird Rock, Torquay (9 specimens); Spring Creek, Torquay (8); Bird Rock cliffs, Torquay (2); below Bird Rock cap between Fishermans Steps and Bird Rock, Torquay (1); Geological Survey of Victoria locality Ad24, Bird Rock (1) and Ad23, Bird Rock (1).

Description. Shell very small for genus, delicate, highly glazed, umbilicate posteriorly, very globose with short, very narrow anterior rostrum; rostrum supported by very weak extensions of base. Spire depressed, covered with thin callus, of 3 teleoconch whorls. Protoconch 3.5 smooth whorls, axis tilted slightly from axis of shell.

Posterior canal very short, strongly bent to left, bounded on columellar side by prominent blunt ridge. Anterior canal short, deeply sunk into rostrum. Aperture virtually crescent shaped, narrowest medially; outer lip with 20–26 relatively thick, elongate teeth, extending along entire lip; inner lip with 16–22 well developed, short teeth, extending along entire lip, almost nodulate on anterior half, more elongate posteriorly. Fossula wide, flat to slightly concave, slightly notched anteriorly on interior side and bounded anteriorly by weak ridge.

Dimensions	L	W	H	LT	CT
Holotype P308716	39	27	21	26	20
Paratype P308717	39	30	24	24	24

Time range. Janjukian, Late Oligocene.

Remarks. Specimens of this species are not common. This is the smallest species of the genus and seems to be ancestral to *Umbilia* (*U.*) *leptorhyncha* (McCoy). It differs from *U.* (*U.*) *leptorhyncha* by its smaller size, being nearly half the length, by having a relatively short anterior rostrum, and by having relatively thicker teeth. The anterior flanges supporting the rostrum present in *leptorhyncha* are scarcely developed in this species. The species shows little resemblence to the putative ancestor of

Umbilia, ?*Palaeocypraea eripnides* sp. nov., or to the other species of *Umbilia* found at the same horizon, *U.* (*U.*) *platyrhyncha*. It may have developed from an undescribed species of *Cypraeorbis* from the Late Eocene of Western Australia by weakening of the fossula and extension of the anterior canal. *Cypraeorbis* sp. has a short anterior canal and a deep concave fossula bounded on the anterior by a thick ridge and with a notch in the interior margin immediately behind the ridge.

Umbilia (*Umbilia*) *leptorhyncha* (McCoy, 1877)

Figures 16A–H

Cypraea (Luponia) leptorhyncha McCoy, 1877: 35, pl. 49 fig. 1, 1a–c.—Harris, 1897: 207.

Cypraea leptorhyncha.—Tate, 1890: 208.

Gisortia leptorhyncha.—Vredenburg, 1927: 42.

Umbilia (Rhynchocypraea) leptorhyncha.—Schilder, 1935: 343, fig. 27.

Rhynchocypraea leptorhyncha.—Lorenz, 1989: 7, fig.

Type material. Lectotype P12133, McCoy's figured specimen chosen herein. Paralectotypes P308726–P308729. Origin unknown (possibly J. Kershaw, 1875).

Type locality. "Near foot of Mount Eliza and Mount Martha, Mornington". The paralectotypes are labelled near Mount Martha. The matrix on the lectotype indicates that it was collected at Fossil Beach, i.e. PL3078 Shore platform at Fossil Beach, 3 km S of Mornington, Victoria. AMG Western Port 273653. Fyansford Formation, Balcombian, Middle Miocene.

Occurrence and material. Batesfordian. Gellibrand Formation: PL3043 Kennedys Creek cutting (2 specimens); Fyansford Formation: Curlewis (2).

Balcombian. Fyansford Formation: PL3078 Fossil Beach (16 specimens); Balcombe Bay (29); near Mount Martha (4); Mornington (6); Schnapper Point (2); PL3069 Red Hill (1); PL3072 Orphanage Hill (1); PL3077 Altona Bay Coal Shaft (1); Shelford (1). Muddy Creek Formation: PL3082 Clifton Bank (25); Muddy Creek (6); Hamilton (3). Cadell Marl: Murray River cliff, 4 miles downstream from Morgan, South Australia.

Bairnsdalian. Fyansford Formation: Grices Creek (4 specimens); Lower beds, Grices Creek (2); Mount Eliza (1); PL3104 S of Manyung Rocks; PL3097 Murgheboluc 2B (2); PL3100 Murgheboluc 4A (1 and 1 fragment); Inverleigh (1 fragment); Overburden, Batesford Limestone Quarry (1).

Description. Shell of medium size for genus, thin shelled, delicate, highly glazed, umbilicate posteriorly, globosely pyriform, tapering abruptly to narrow anterior rostrum; rostrum supported by narrow triangular extensions of base. On some specimens, rostrum bearing deep oblique groove on dorsal surface formed by anterior end of dorsal line (mantle margins). Spire depressed, covered with thin callus; 5 teleoconch whorls. Protoconch of 2.5 smooth whorls with axis slightly tilted from axis of teleoconch whorls.

Posterior canal, very short, strongly bent to left, bounded on columellar side by low sharp ridge. Anterior canal short, deeply sunk into rostrum. Aperture very sinuous, narrowest medially, widest posteriorly; outer lip with 35–39 thin, well developed, well spaced teeth, extending along entire lip; inner lip with 32–34 well developed, thin, widely spaced teeth, extending along entire lip; teeth longer in middle section, with some short teeth intercalated, becoming very short posteriorly and extending onto posterior canal wall; teeth almost lamellar on some specimens. Fossula moderately developed, rather elongate, narrow, depressed, inner border slightly thickened and weakly indented. Base and portion of sides covered with very thin callus.

Dimensions	L	W	H	LT	CT
Lectotype P12133	63	40	33	39	33
Paralectotype P308726	59	39	32	33	29
Paralectotype P308728	50	34	28	35	28

Time range. Batesfordian–Bairnsdalian, Middle Miocene.

Remarks. The geographic distribution of this species is probably much wider than that given above and it is more common than the numbers would suggest, because specimens are generally so fragile that they have not survived intact at many localities. The specimens from Curlewis and Kennedys Creek have the columellar side of the posterior canal very well developed when compared to specimens from younger horizons. The apertural teeth are also not so well developed and look more like those of *U.* (*U.*) *prosila* sp. nov.

Umbilia petilirostris sp. nov.

Figures 13A–C, 15D, F–G

Umbilia capricornica Lorenz, 1989: 2, pl. 2 (part, deep water variants).

Cypraea capricornica.—Wilson, 1993: 192, pl. 30, fig. 6 (part).

Type material. Holotype F86962, paratypes F86963, F86967, presented Alan Limpus, 30 Jun 1997.

Type locality. Capricorn Channel, off Lady Musgrave I., Queensland, 264–252 m.

Occurrence. Capricorn Channel, Queensland – type locality; off Fitzroy Reef, 249 m; off One Tree I.; off Swains Reef, 188–201 m.

Description. Shell of medium to large size for genus, thin shelled, highly glazed, posteriorly umbilicate, very globose, tapering abruptly to short anterior rostrum; rostrum supported by very narrow, thin extensions of the base and bearing 2 very weakly developed tubercles, separated on some specimens by wide, shallow, oblique groove. Spire depressed, covered with thin callus; teleoconch whorls 3; protoconch of 2.5 smooth whorls, axis tilted slightly from axis of teleoconch.

Posterior canal very short, strongly bent to left, bounded on columellar side by thin high wall. Anterior canal relatively wide, deeply immersed in rostrum. Aperture sinuous; outer lip with 24–34 short, well developed teeth, extending along entire lip; inner lip with 20–32 short, well developed teeth, extending along entire lip and on some specimens extending onto posterior canal wall; teeth more elongated posteriorly and almost nodulate anteriorly above fossula. Fossula relatively long and wide, concave with weak depression on inner border.

Dorsum grey brown with brown spots particularly near base. Base white with dark brown patch on columellar side.

Dimensions.	L	W	H	LT	CT	
Holotype F86962	76	49	40	34	32	
Paratype F86963	67	47	38	28	28	off Fitzroy Reef
Paratype F86967	53	34	28	29	24	off Swains Reef

Remarks. This species has been confused with *Umbilia* (*U.*) *capricornica* Lorenz, but differs by its more globose shape, more weakly developed posterior rostrum, and by having the columellar side of the posterior rostrum developed as a thin wall. It seems to be the living descendent of *U.* (*U.*) *leptorhyncha* from which it differs by its much larger size, the presence of a seemingly relatively larger fossula, and by having the posterior canal as a prominent thin wall on the columellar side, whereas *U.* (*U.*) *leptorhyncha* has a low ridge. The two species are very similar in shape though perhaps U. (*U.*) *petilirostris* is even more globose and with shorter labial teeth than *U.* (*U.*) *leptorhyncha.*

Umbilia* (*Umbilia*) *siphonata Chapman, 1922

Figures 17A–E; 18A–F; 19A–B

Cypraea sphaerodoma var. ? Tate, 1890: 210.
Cypraea siphonata Chapman, 1922: 12, pl. 3 fig. 16.
Gisortia breviplicata Schilder 1926: 361, 373.
Umbilia (Palliocypraea) breviplicata Schilder, 1935: 345, fig. 30.
Umbilia sp.— Burgess, 1989: 11, fig. C.—Lorenz, 1989: fig. 5.

Type and figured material. Holotype P13243, F.A. Cudmore, presented 8 Oct 1920.

Holotype of *Gisortia breviplicata* P26904, John Dennant Collection. There are two specimens in the Dennant Collection from Muddy Creek labelled *Cypraea sphaerodoma.* One is near complete (P302803), but lacks the anterior canal and so could not be that referred to by Tate. It is also too small. The other specimen was found in fragments. This shell is very fragile, the dorsum having had been subjected to boring organisms (a common feature on many specimens of larger cowries) and at some stage it had been broken. This specimen was repaired to enable measurements to be taken, and on repair it was found that Tate's measurements fitted it.

Figured specimens. P12569, purchased R.H. Annear, 23 Jan 1912. P302803, John Dennant Collection. P14835, Noel J. Shaw, 13 Mar 1950.

Type locality. 'Below Overland Corner (left bank), and second cliff showing strata, below Waikerie, Murray River, South Australia. From upper part of the cliff below the Kalimnan beds'.

Occurrence and material. Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (1 specimen); Muddy Creek (6 and 11 fragments). Fyansford Formation: PL3069 Red Hill, Shelford (1 and 2 fragments); Orphanage Hill, Fyansford (1 fragmentary specimen). PL3074 Heatherton test shaft. Morgan Limestone: Broken Cliffs opposite Waikerie, River Murray cliffs, South Australia (selenite replacement, 1 fragmentary specimen, SAM P35237).

Bairnsdalian. Bairnsdale Limestone: 1 mile from Bairnsdale (1 natural internal mould)?; Nicholson River (1 specimen with remains of shell). Fyansford Formation: PL3097 Murghebolue 2B (2 specimens); PL3098 Native Hut Creek, S of Hamilton Highway (1 fragment); PL3102 Warrenbine Creek (1); PL3104 Manyung Rocks (1 and 1 fragment); Griees Creek (2). Gellibrand Formation: PL3087 Lake Bullen Merri (1 and several fragments). Bookpurnong Beds: PL3133 Wookool Bend (1); PL3298 Wookool Homestead (1 fragment). PL6667 NW of Wookool Homestead (2 fragmentary specimens).

Description. Shell large for genus, subhemispherical, tapering rapidly anteriorly to form narrow canal; prominently rostrate posteriorly. Transverse section of last whorl oval. Spire umbilicate, covered with glaze, whorls scarcely visible. Protoconch of 3.5 smooth, dome-shaped whorls, tilted at an angle to teleoconch whorls. Teleoconch of about 3 whorls.

Posterior canal extremely elongate, reflexed dorsally on most specimens, on others straight; weak longitudinal sulcus present on left dorsal side extending from end of canal into umbilicus; base of canal supported by lateral extensions of

base; left extension triangular, prominent; right extension elongate, narrow. Anterior canal moderately short (much shorter than posterior canal), reflexed dorsally on some specimens (extremely so on 1 specimen), almost straight on others, sometimes bearing 2 very weak dorsal tubercles; dorsal surface of canal bearing long sulcus, obsolete on some specimens; base of canal supported by narrow elongate extensions of the base, right extension longer than left.

Aperture sinuous; outer lip wide, slightly concave close to inner edge of lip, convex towards periphery of base, bearing 30–34 relatively thin but prominent teeth, well separated by interspaces about twice width of teeth; teeth fading posteriorly; inner lip with 26–28 teeth slightly wider than labial teeth, very short anteriorly, longer and slightly weaker posteriorly. Fossula broad, very slightly depressed.

Base on columellar side slightly swollen in middle and concave posteriorly and anteriorly towards canals.

Dimensions	L	W	H	LT	LT
Holotype P13243	135	63	50	–	–
P26904	133	76	58	30	28
Figured specimen P12569	144	83	65	34	27
Figured specimen P302803	111	70	56	30	28
Figured specimen P14835	168	85	65	30	26

Time range. Balcombian–Bairnsdalian, Middle Miocene.

Remarks. This is the second largest species of Australian fossil cowry, exceed only by specimens of *Zoila gigas* (McCoy). The species was recorded as a questionable and unnamed variety of *Cypraea sphaerodoma* by Tate (1890), based on a specimen from Muddy Creek in the collection of John Dennant. In 1922 Chapman named *C. siphonata* based on a natural mould in limestone from the Murray River near Waikerie and compared it with *C sphaerodoma*. Chapman confused anterior and posterior canals in his description. Schilder (1926) recognised that Tate's variety was a new species and formally named it, based on Tate's description and material. Later Schilder (1935) stated that *C. siphonata* was 'allied' to *C. breviplicata*, including both species in the subgenus *Palliocypraea* on the basis of their basal extremities being much expanded. In fact, the extensions of the base on these two are no different from those of any other of the fossil species included in *Umbilia* (*Umbilia*) and for this reason, the two species are placed in this subgenus.

The holotype of *C. siphonata* has sufficient characters preserved to show that *breviplicata* is a synonym. The long posterior canal is the same as that on a specimen of *breviplicata* from Grices Creek and the whorl profile is also identical in shape. A rubber cast taken from the holotype mould shows teeth identical to those on specimens of *breviplicata* and the base has the same slight swelling in the middle of the columella side.

This species is rare in the Fyansford Formation but not uncommon in the Muddy Creek Formation. The occurrence of both this species and *Umbilia eximia* in the Bookpurnong Beds of the Murray Basin suggests that this formation is probably Bairnsdalian, that is Middle Miocene, rather than Late Miocene in age.

Of the two specimens from the Bairnsdale Limestone, one is an internal mould. It is recorded with a query but the size of the specimen and the elongated anterior canal seems to indicate that it is probably this species. The other specimen is incomplete but has significant remnants of original shell preserved, so that the identification seems certain. It has the typical oval outline of the dorsum and teeth typical of *U. siphonata*.

Umbilia (*Umbilia*) *armeniaca* Verco, 1912

Figure 12B, D–E

Cypraea umbilicata var. armeniaca Verco, 1912: 211, 213, pl. 10 figs 1–3.

Cypraea (Umbilia) armeniaca.—Wilson, 1993: 191, pl. 30 figs 12–16.

Type and figured material. Type stated to be in J.C. Verco collection. Verco presented his collection to the South Australian Museum, but the holotype cannot be located there (T. Lapcrousaz, Collection Manager, Marine Invertebrates, pers. comm., 12 Oct 1999).

Paratype AM C35583 (ex E3842), Verco's 'slightly older specimen'. Paratype AM 121153 (ex E3843), Verco's 'youngest example'. The holotype is not in the Australian Museum collection.

Figured specimen, F27194, C.J. Gabriel collection, presented 29 Aug 1963.

Type locality. '100 fathoms, Great Australian Bight, 60 miles from shore, 80 miles west of Eucla'.

Description. Shell solid, globular, pyriform, of large size for the genus, tapering abruptly anteriorly and produced into a very short rostrum. Spire deeply umbilicate, covered with glaze, 2 whorls visible.

Posterior canal very short, margins thiekened, twisted to left. Anterior eanal very short, embraced by rostrum, supported by weak lateral flanges. Aperture sinuous, outer lip with 32–40 teeth, inner lip with 26–31 teeth, whieh become slightly weaker posteriorly. Fossula on some speeimens wide, distinetly depressed.

Colour variable; aprieot, orange, eream to almost lilac blotches on white to grey ground, darker patches on anterior and posterior rostra. Ventral surfaee very pale, with many speeimens having dark pateh in eentre of base.

Dimensions	L	W	H	LT	CT
Figured Speeimen F27194	89	57	51	39	31

Distribution. Albany, Western Australia to Port Lincoln, South Australia, 30–200 metres.

Remarks. To date, this speeies has not been found as a fossil. This may be accounted for by its inhabiting deep water over most of its known range and there being no outerops of deep water sediments of appropriate age, though speeimens of *U.* (*U.*) *armeniaca* have been eolleeted by divers in Thorny Passage near Port Lincoln and at Esperanee in 30 metres (C. Goudey eollection).

Umbilia* (*Umbilia*) *capricornica Lorenz, 1989

Figure 14D–H

Umbilia capricornica Lorenz, 1989: 2–8, pl. 2 (part), figs 3–4.

Cypraea (Umbilia) capricornica.—Wilson, 1993: 192, pl. 30 figs 1–5, 8.

Type and figured material. Haus der Natur-Cismar, Germany. Holotype HNC 22453.

Figured speeimens F85329, F85330, presented Alan Limpus, 30 Jun 1997.

Type locality. Swains Reef, 120–125 fm, trawled Feb 1989.

Description. Shell somewhat small for genus, pyriform, tapering relatively abruptly anteriorly to form a moderately developed rostrum bearing 2 moderately developed dorsal tubercles; somewhat rostrate posteriorly. Spire umbilieate, eovered with thiek glaze

Posterior canal short, margins thickened, twisted to left. Anterior canal embraced by rostrum supported by weak lateral flanges. Aperture sinuous, outer lip with 28–34 teeth; inner lip with 22–29 teeth. Fossula well developed, rather wide, concave, projecting slightly into body of shell. On some speeimens slight trace of sulcus running from left side of posterior eanal aeross dorsum on to anterior rostrum between tubercles.

Colour eream to white with irregular brown spots and patehes on anterior rostrum and on either side of posterior eanal; ventral surfaee brown to white.

Dimensions	H	W	H	LT	CT
Figured speeimen F85329	82	45	39	29	29
Figured specimen F85330	60	36	29	30	22

Distribution. Swains Reefs, 165–420 m; Capricorn Channel, off Lady Musgrave I., 220 m.

Remarks. Lorenz (1989) distinguished this speeies from *Umbilia* (*U.*) *hesitata* by the presenee of well developed tubereles on the anterior rostrum, the eoarser apertural dentition and by the presenee of a visible fossula margin. The general colour and eolour pattern of *U.* (*U.*) *capricornica* are very similar to those of *U.* (*U.*) *hesitata*, the posterior rostrum is very similar, the anterior rostrum is more slightly produced and the dorsal tubercles are more strongly developed; however, the overall morphology of *U.* (*U.*) *capricornica*, ineluding the apertural dentition, is not very different from that of northern speeimens of *U.* (*U.*) *hesitata*. Even the fossula in some speeimens of *U.* (*U.*) *hesitata* has a slight resemblanee to that in *U.* (*U.*) *capricornica*. Nevertheless, there do seem to be sufficient differenees between them to maintain specific separation of the two taxa.

Lorenz stated that the *U.* (*U.*) *capricornica* was more closely allied with the fossils *U.* (*U.*) *eximia* and *U.* (*Palliocypraea*) *gastroplax* than with the other living speeies; however, as noted above, *U.* (*U.*) *capricornica* is not greatly different from *U.* (*U.*) *hesitata*. The resemblance to *U.* (*U.*) *eximia* is not so great, but both *U.* (*U.*) *hesitata* and *U.* (*U.*) *capricornica* are probably descended from *U.* (*U.*) *eximia*.

***Umbilia* (*Palliocypraea*)** Cossmann, 1906

Rhynchocypraea (Palliocypraea) Cossmann, 1906: 239

Gisortia (Palliocypraea).—Vredenburg, 1927: 26, 60

Umbilia (Palliocypraea) Schilder, 1935: 342.—Schilder, 1939: 186.

Type species. Cypraea gastroplax McCoy, 1867 by original designation; Miocene, Victoria.

Diagnosis. Shell relatively thin, of medium size for the family, body of shell pyriform with prominent thin flat flange extending around periphery of body to give a eireular outline. Rostra and siphonal eanals ineor-porated into flange. Other shell features similar to *Umbilia*.

Time range. Batesfordian-Balcombian, Early Miocene to Middle Miocene.

Distribution. Victoria

Remarks. The overall shell morphology of the only species assigned to the subgenus is very similar to that of *Umbilia* sensu stricto, with the exception of the prominent lateral flange encircling the body of the shell. This flange can be envisaged as an extensive development of the triangular basal extensions that support the rostra in species of *Umbilia* sensu stricto. As mentioned above, *U. siphonata*, included in this subgenus by Schilder (1935), has basal flanges similar to those of other species of *Umbila* (*Umbilia*), and is placed in the latter subgenus.

Umbilia (*Palliocypraea*) *gastroplax* (McCoy, 1867)

Figures 19D–E; 20A–D; 21A–D

Cypraea gastroplax McCoy, 1867a: 18.—McCoy, 1867b: 194.

Cypraea (Aricia) gastroplax McCoy, 1875: 20, pl. 16 figs 1–1a, pls 17–18 figs 2–2a. Figures reversed in lithography.

Rhynchocypraea (Palliocypraea) gastroplax.—Cossmann, 1906: 239, pl. 9 figs 10–11.

Palliocypraea gastroplax.—Chapman, 1929: 202–205, pls 19–20.—Lorenz, 1989: fig. 5.

Umbilia (Palliocypraea) gastroplax.—Schilder, 1935: 342, 345.

Type and figured material. Holotype P12140. The original drawings for McCoy's plate are dated Jul 1861 which proves that the specimens were collected before then and so almost certainly by Alfred Selwyn, Geological Survey of Victoria, during his survey of the Mornington Peninsula in 1854. The specimen was originally registered under number 8060 (registered in 1861) under the old registration system, but the entry has no further information beyond the locality 'Mt. Eliza to Mount Martha'.

Figured specimens. P13373, presented by Walter Greed 3 Mar 1924. P24869, G.B. Pritchard Collection. P302852. T.A. Darragh 23 Oct 1971. P302854, Nielson Collection, presented Mrs W.A. Nielson, 1 May 1985.

Type locality. 'Tertiary limestone of the tract between Mount Eliza and Mount Martha'. The preservation of the holotype in a block of septarian limestone indicates that it came from PL3078 Fossil Beach.

Occurrence and material. Batesfordian. Gellibrand Formation: PL3048 Boornong Rd cutting (2 fragments).

Balcombian. Muddy Creek Formation: PL3082 Clifton Bank (2 specimens and 2 fragments). Fyansford Formation: PL3077 Altona Bay Coal Shaft (1 fragment); PL3078 Fossil Beach (4 specimens and 2 fragments); Overburden, Batesford Limestone Quarry (1 specimen and 2 fragmentary specimens).

Description. Shell of average size for genus; last whorl pyriform, tapering gently anteriorly with prominent wide flange extending around periphery of whorl; flange width about half width of last whorl, flange thickness about 1 mm. Transverse section of last whorl subtriangular. Spire umbilicate; spire whorls scarcely visible, covered with glaze.

Posterior canal incorporated into shell flange, slightly reflexed dorsally, subcylindrical, almost tubelike anteriorly, almost closed on some specimens, closed on others; weak longitudinal sulcus present on left dorsal side of posterior canal and extending from middle of canal into umbilicus and across dorsum to posterior canal on some specimens. Anterior canal subcylindrical incorporated into shell flange; dorsal surface of canal bearing very weak sulcus. Aperture narrow, sinuous; with 30–39 labial teeth; teeth prominent, thin, short, tooth interspaces about twice width of teeth; inner lip with 24–30 short thin teeth about half width of interspaces; teeth set on narrow rounded ridge running from anterior canal to posterior canal. Fossula elongate, narrow, slightly depressed. Ventral surface on both sides of aperture uniformly convex.

Dimensions	L	W	H	LT	CT
Holotype P12140	96	52	38	–	–
Figured specimen P24869	102	55	41	39	30
Figured specimen P13373	97	52	37	30	36+
Figured specimen P302852	88	41	33	30	24
Figured specimen P302854	121	51	39	30	28

Time range. Batesfordian–Balcombian, Early Miocene–Middle Miocene.

Remarks. Chapman (1929) suggested that the flange was an adaptation to enable the animal to creep over 'an even-surfaced oozy sea-bed'. The specimens from PL3048, Boornong Rd. cutting, consist of fragments of the flange. It is assumed that they belong to this species, though the locality is of Batesfordian age, whereas all the other specimens have been recorded only from localities of Balcombian age.

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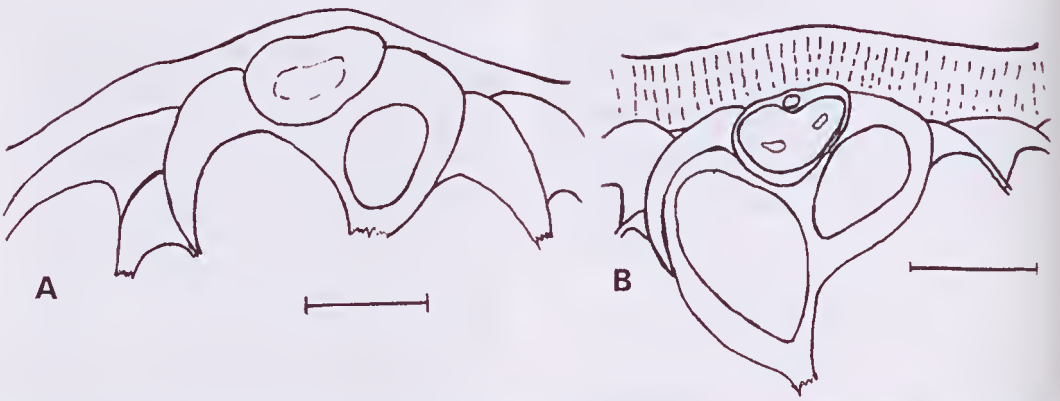

Figure 1. Sections through protoconchs. Bar scale 1 mm. A, *Umbilia (U.) angustior* (Pritchard), P304357, Picnic bed, Hordern Vale. B, *Umbilia (U.) eximia* (Sowerby), P304355, PL3078, Fossil Beach.

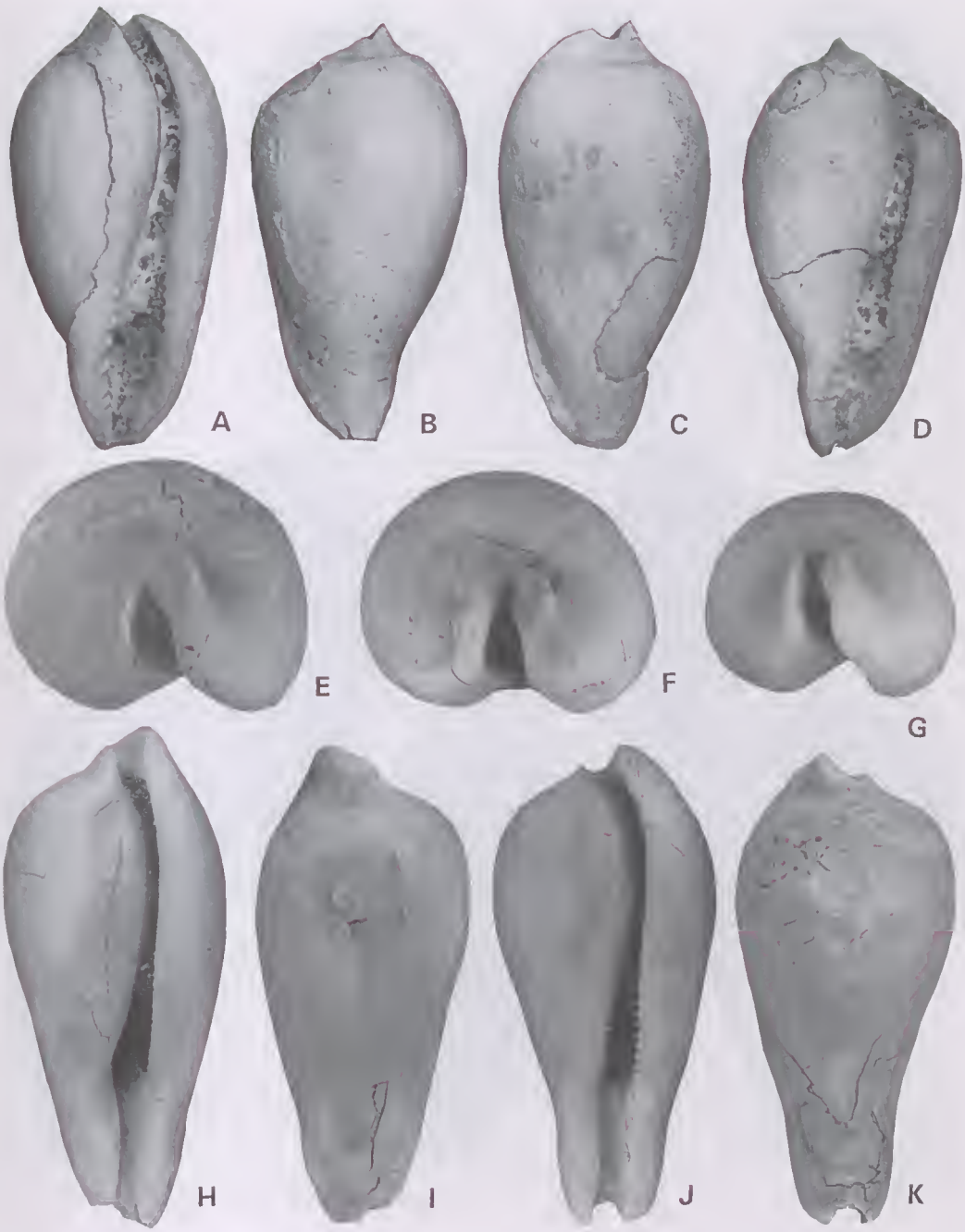

Figure 2. A–D, ?*Palaeocypraea eripnides* sp. nov. A, C, NZGNS TM 8124, holotype, Pitt I., New Zealand, x 1.5. B, D, NZGNS TM 8125, paratype, Pitt I., New Zealand, x 1.2. E–F, H–K, *Umbilia (U.) platyrhyncha* (McCoy). E, P12138, holotype, Ad 22, Bird Rock cliffs, x 1.0. F, P59169, Ad 22, Bird Rock cliffs, x 1.1. H–I, P302784, Bird Rock cliffs, x 0.9, x 0.8. J–K, P12138, holotype, Ad 22, Bird Rock cliffs, x 0.7. G, *Umbilia (U.) angustior* (Pritchard), P2671, holotype, Table Cape, Tasmania, x 1.1.

Figure 3. A–F, *Umbilia (U.) platyrhyncha* (McCoy). A–B, P59169, Ad 22, Bird Rock cliffs, x 0.8. C–D, P302697, cliffs west of Bird Rock, x 0.8. E, P12138, holotype, Ad 22, Bird Rock cliffs, x 0.75. F, P302784, Bird Rock cliffs, x 0.8. G–I, *Umbilia (U.) angustior* (Pritchard), P302688, PL3032, x 1.0.

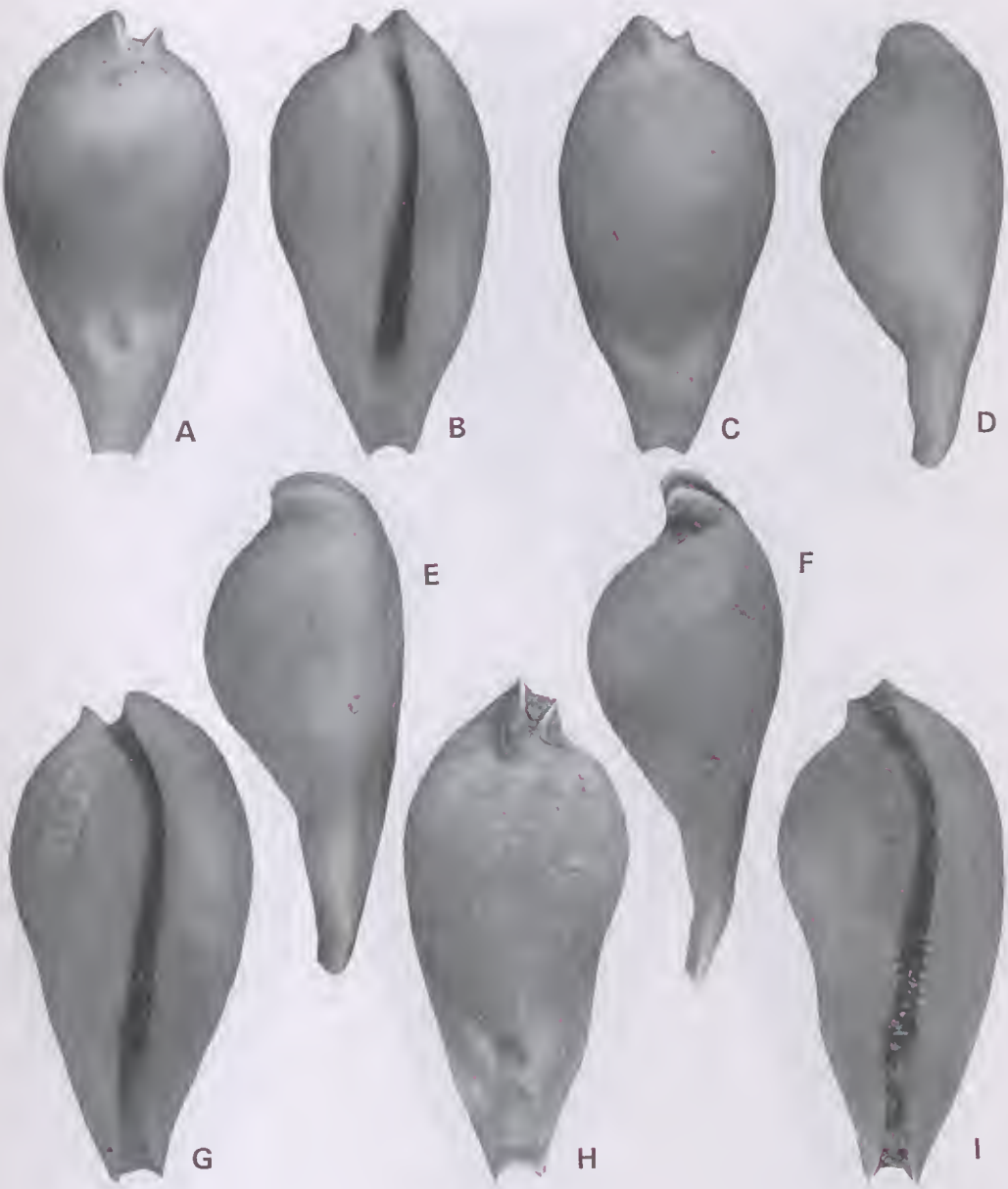

Figure 4. A–I, *Umbilia (U.) angustior* (Pritchard). A, E, G, P2671, holotype, Table Cape, Tasmania, x 0.9, x 1.0, x 1.0. B–D, P302703, PL3037, Hordern Vale, x 1.1. F, H–I, P302785, Table Cape, Tasmania, x 1.0.

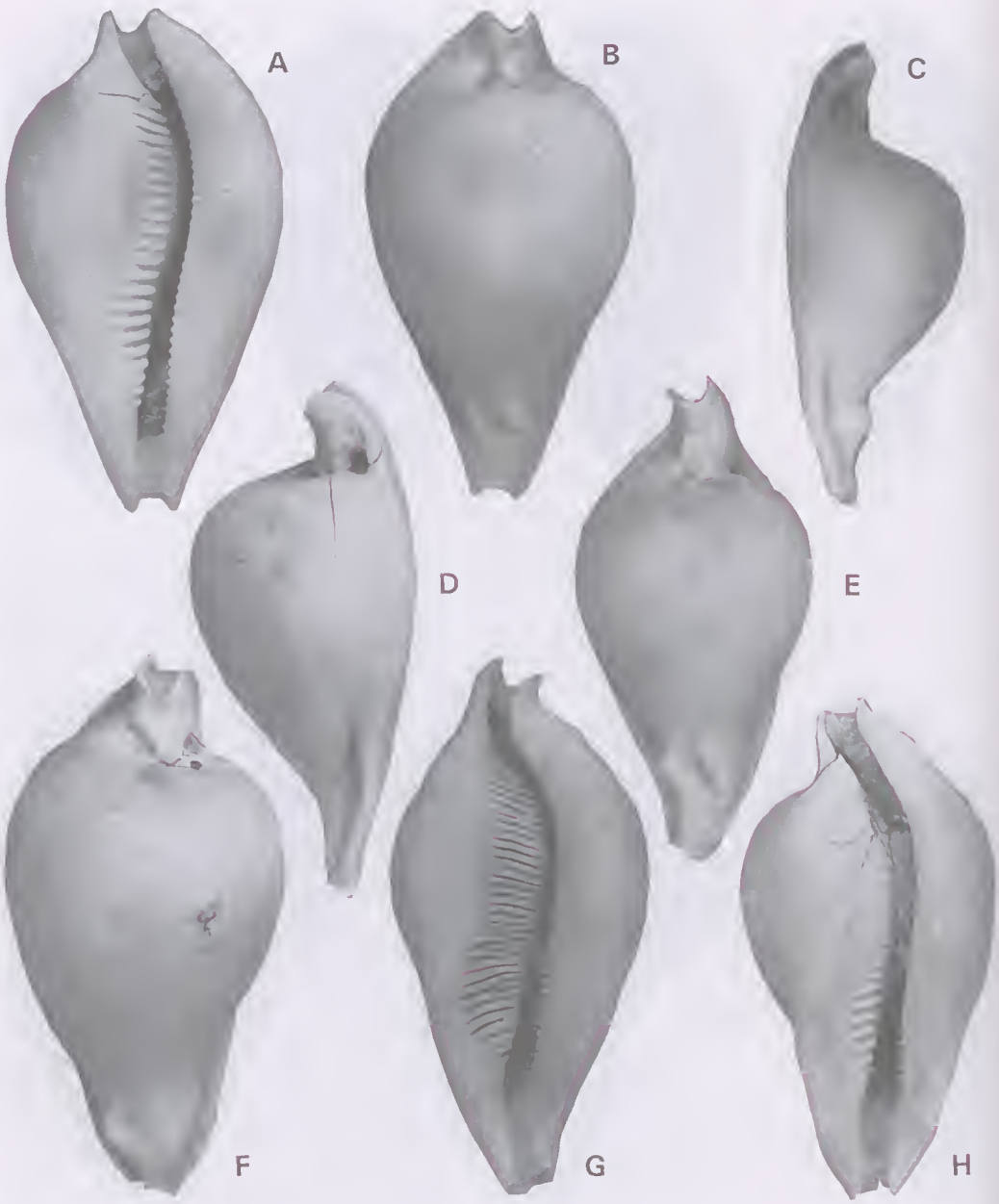

Figure 5. A–H, *Umbilia (U.) eximia* (Sowerby). A–B, P5296, syntype of *Cypraea eximia brevis* McCoy, Aw 9, Gellibrand River, x 0.9. C, E, G, BMNH G9694, holotype, Franklin Village, Tasmania, x 0.8, x 0.8, x 0.9. D, F, H, BMNH G40069, holotype of *Umbilia (U.) brevis frankstonensis* Schilder, Grices Creek, x 0.7, x 0.8, x 0.7.

Figure 6. A–H, *Umbilia (U.) eximia* (Sowerby). A, C, P16171, syntype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.7. B, D, G, P12135, lectotype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.7. E–F, H, P12136, leetotype of *Cypraea eximia brevis* MeCoy, between Mt Eliza and Mt Martha, x 0.9.

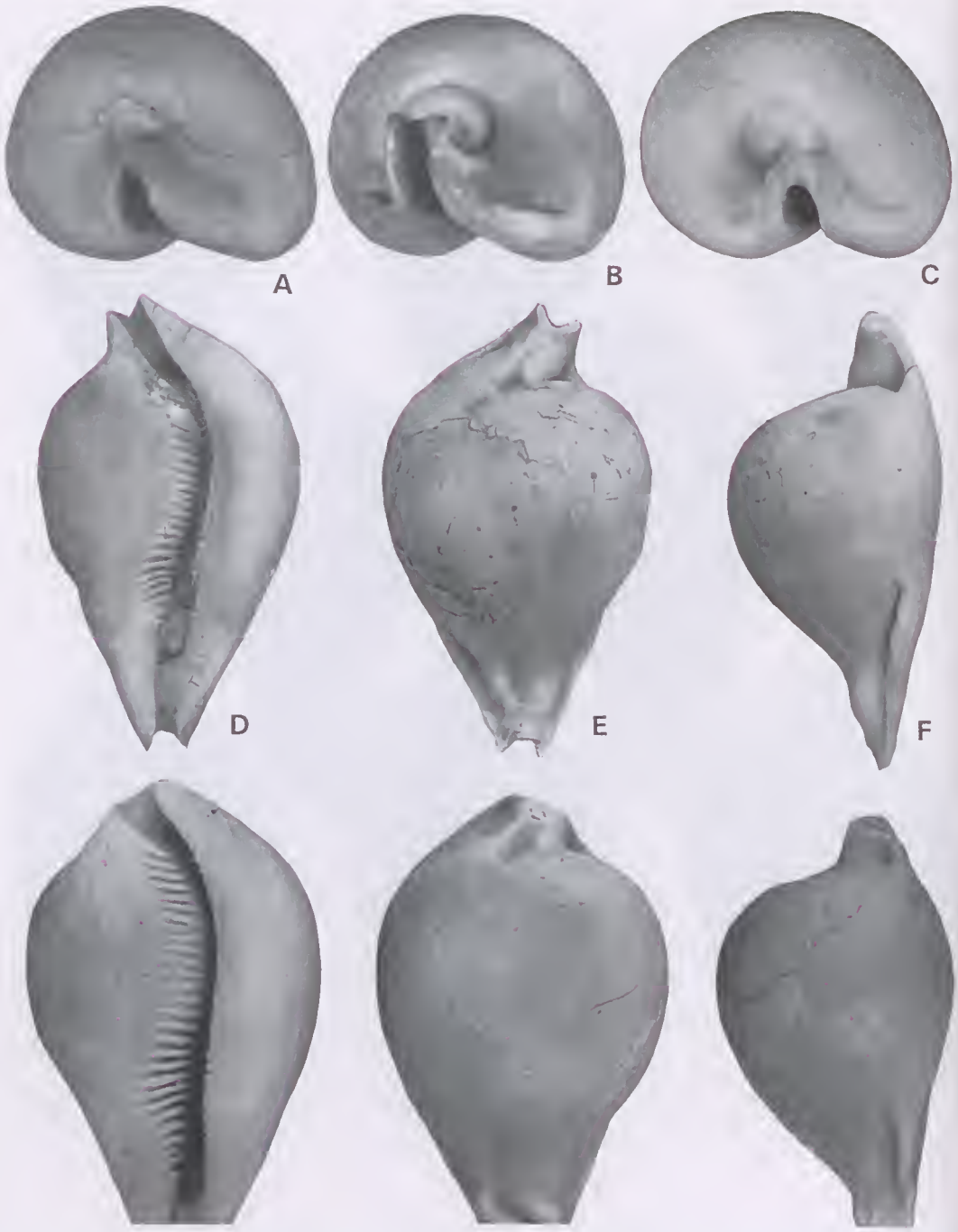

Figure 7. A, *Umbilia (U.) hesitata* (Iredale), P302781, PL1264, Flinders I., x 0.75. B–I *Umbilia (U.) eximia* (Sowerby). B, P12135, leetotype of *Umbilia (U.) eximia maccoyi* Schilder, between Mt Eliza and Mt Martha, x 0.9. C, P5296, syntype of *Cypraea eximia brevis* McCoy, Aw 9, Gellibrand River, x 1.1. D–F, SAM T821, holotype of *Cypraea sphaerodoma* Tate, near Morgan, South Australia, x 0.8. G–I, BMNH 70406, holotype of *Umbilia (U.) brevis montisuarthae* Schilder, Mount Martha, x 1.0.

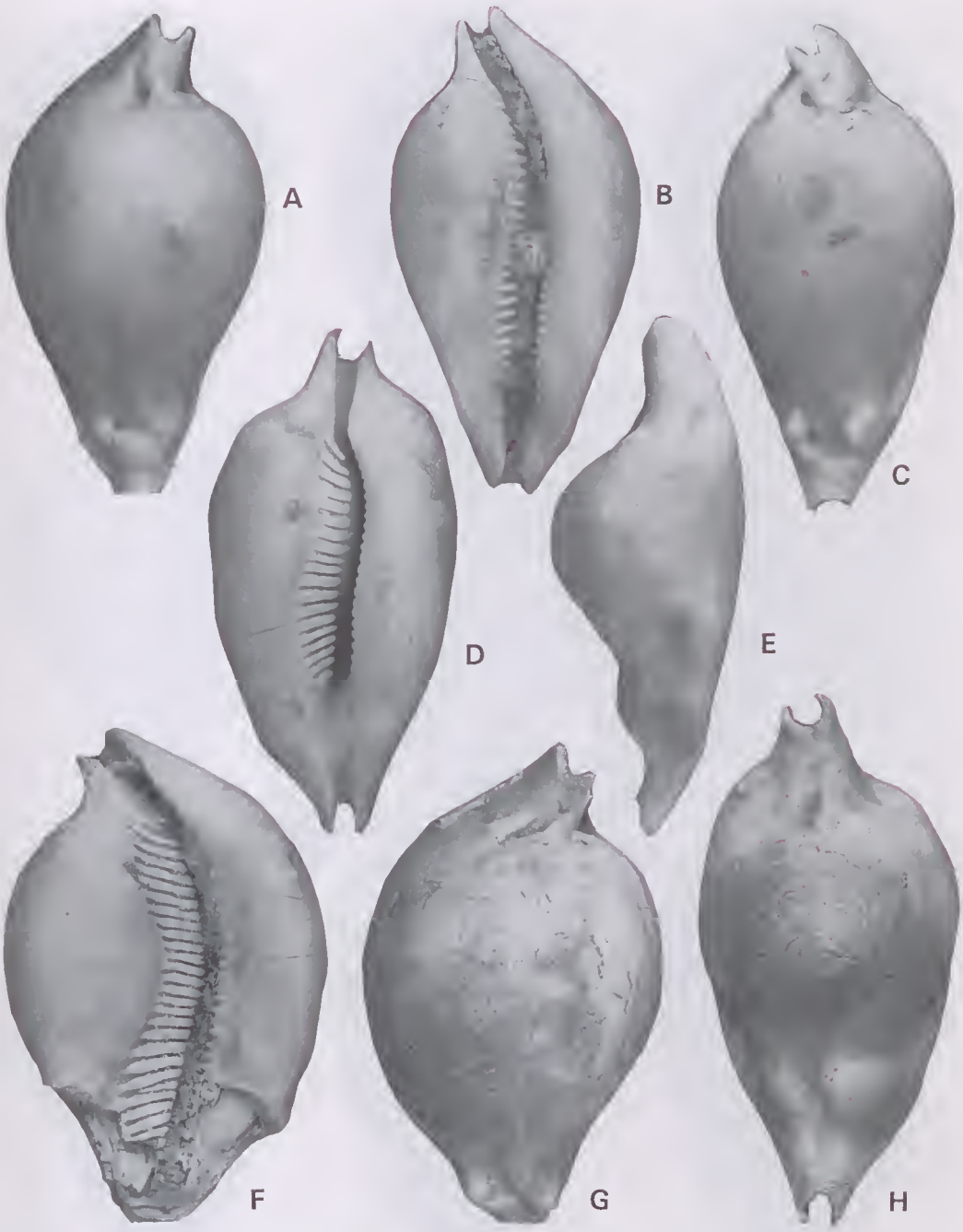

Figure 8. A–H, *Umbilia (U.) eximia* (Sowerby). A–B, P302712, Lake Bullenmerri, x 1.0. C, P302779, lower beds, Grices Creek, x 0.8. D–E, H, P302782, PL3298, x 0.8, x 0.9, x 0.9. F–G, P302716, Rose Hill, x 1.0, x 0.9.

Figure 9. A–H, *Umbilia (U.) hesitata* (Iredale). A, C, E, WAM 89.636a, 2.5 km N of Hampton Tower, Roe Plains, Western Australia, x 0.9, x 0.8, x 0.9. B, D, F, WAM 89.636b, 2.5 km N of Hampton Tower, Roe Plains, Western Australia, x 0.8, x 0.9, x 0.9. G–H, P302717, Rose Hill, x 0.9, x 0.8.

Figure 10. A–I, *Umbilia (U.) hesitata* (Iredale). A, C, SAM T812B, syntype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. B, D, SAM P8339, holotype of *Umbilia cera* Cotton, Abattoirs Bore, South Australia, x 1.1. E, I, P302718, Rose Hill, x 1.1. F, SAM T812A, lectotype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. G–H, P302720, Beaumaris, x 1.1.

Figure 11. A–H, *Umbilia (U.) hesitata* (Iredale). A–C, P302770, PL 1250, Flinders Is, Tasmania, x 1, x 1.1, x 0.9. D–E, P302780, North Memana Drain, Flinders I., Tasmania, x 0.8. F–H, P302781, PL1264, Flinders Is, Tasmania, x 0.8.

Figure 12. A, C, *Umbilia (U.) hesitata* (Iredale), 'beddomei' form, F23116, 50 fm, off Botany Bay, New South Wales, x 1.0, x 0.9. B, D–E, *Umbilia (U.) armeniaca* (Verco), F27194, Great Australian Bight, uncoated, x 0.7, x 0.8, x 0.8. F–H, *Umbilia (U.) hesitata* (Iredale), F4526, off Lakes Entrance, Vietoria, x 0.8, x 0.7, x 0.7.

Figure 13. A–C, *Umbilia (U.) petilirostris* sp. nov., F86962, holotype, Capricorn Channel, off Lady Musgrave I., Queensland, 264–252 metres, A, C x 1.1, D x 1.0. D–E, *Umbilia (U.) hesitata* (Iredale), BMNH 1950.8.28.22, lectotype, x 0.9.

Figure 14. A–C, *Umbilia (U.) hesitata* (Iredale). A, C, SAM T812A, lectotype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. B, SAM P8339, holotype of *Umbilia cera* Cotton, Abattoirs Bore, x 1.1. D–H, *Umbilia (U.) capricornica* Lorenz, D–E, F85330, 108–110 fm, Swains Reef, Queensland, x 1.2. F–G, F85329, 103–105 fm, Swains Reef, Queensland, x 1.0.

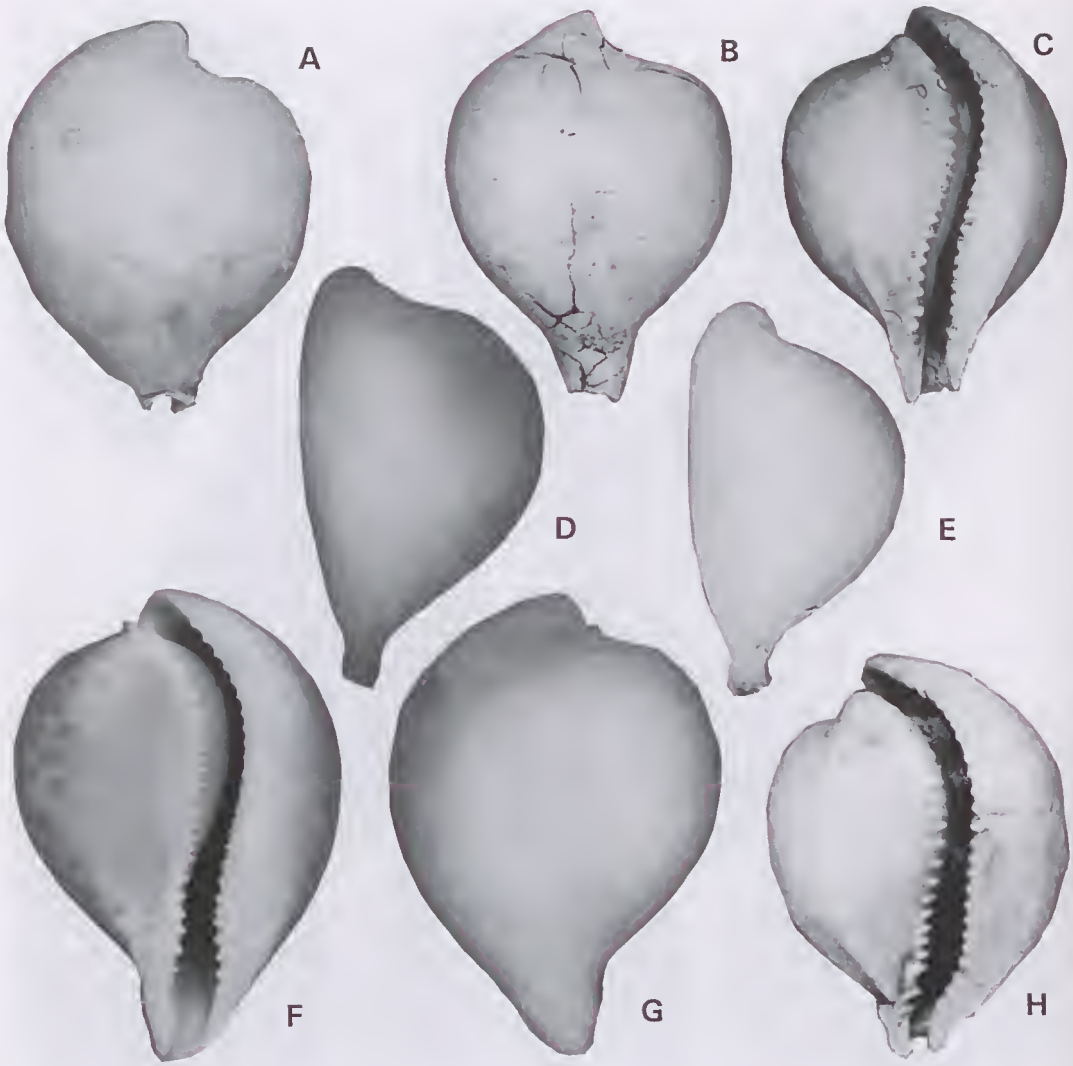

Figure 15. A–C, E, H, *Umbilia (U.) prosila* sp. nov. A, H, P308717, paratype, Bird Rock cliffs, Torquay, x 1.4. B–C, E, P308716, holotype, Bird Rock cliffs, Torquay, x 1.4. D, F–G, *Umbilia (U.) petilirostris* sp. nov. F86963, paratype, 249 m, off Fiztroy Reef, D x 0.8, F–G x 0.9.

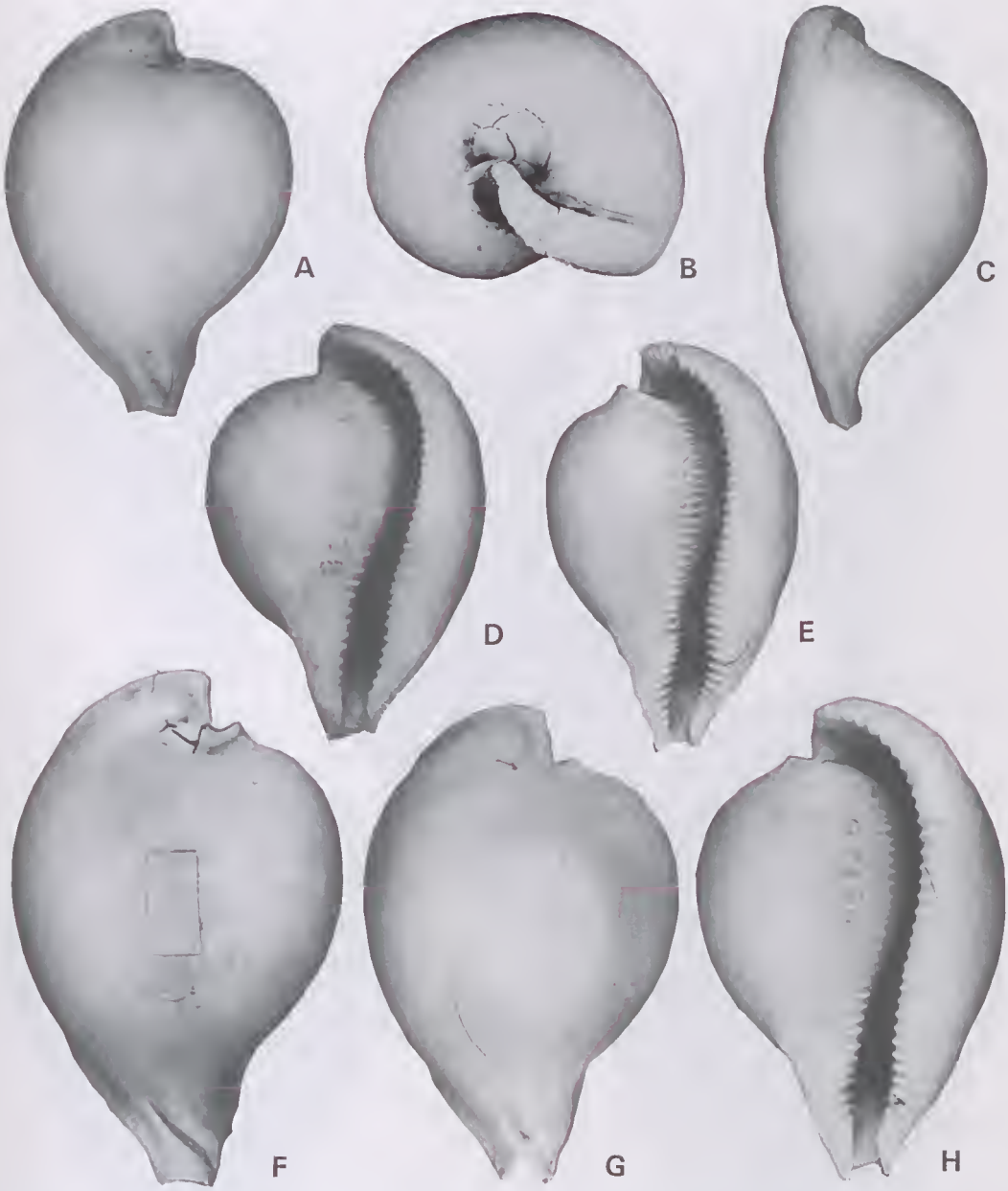

Figure 16. A–H, *Umbilia (U.) leptorhyncha* (McCoy). A, D, P308728, paralectotype, near Mount Martha, x 1.2. B–C, E–F, P12133, lectotype, B x 1.1, C x 1.0, E x 0.9, F x 1.2. G–H, P308726, paralectotype, near Mount Martha, x 1.2.

Figure 17. A–E, *Umbilia (U.) siphonata* (Chapman). A–B, P26904, holotype of *Gisortia breviplicata* Schilder, Muddy Creek, x 0. 6. C, P14835, Grices Creek, x 0.6. D–E, P302803, Muddy Creek, x 0.8.

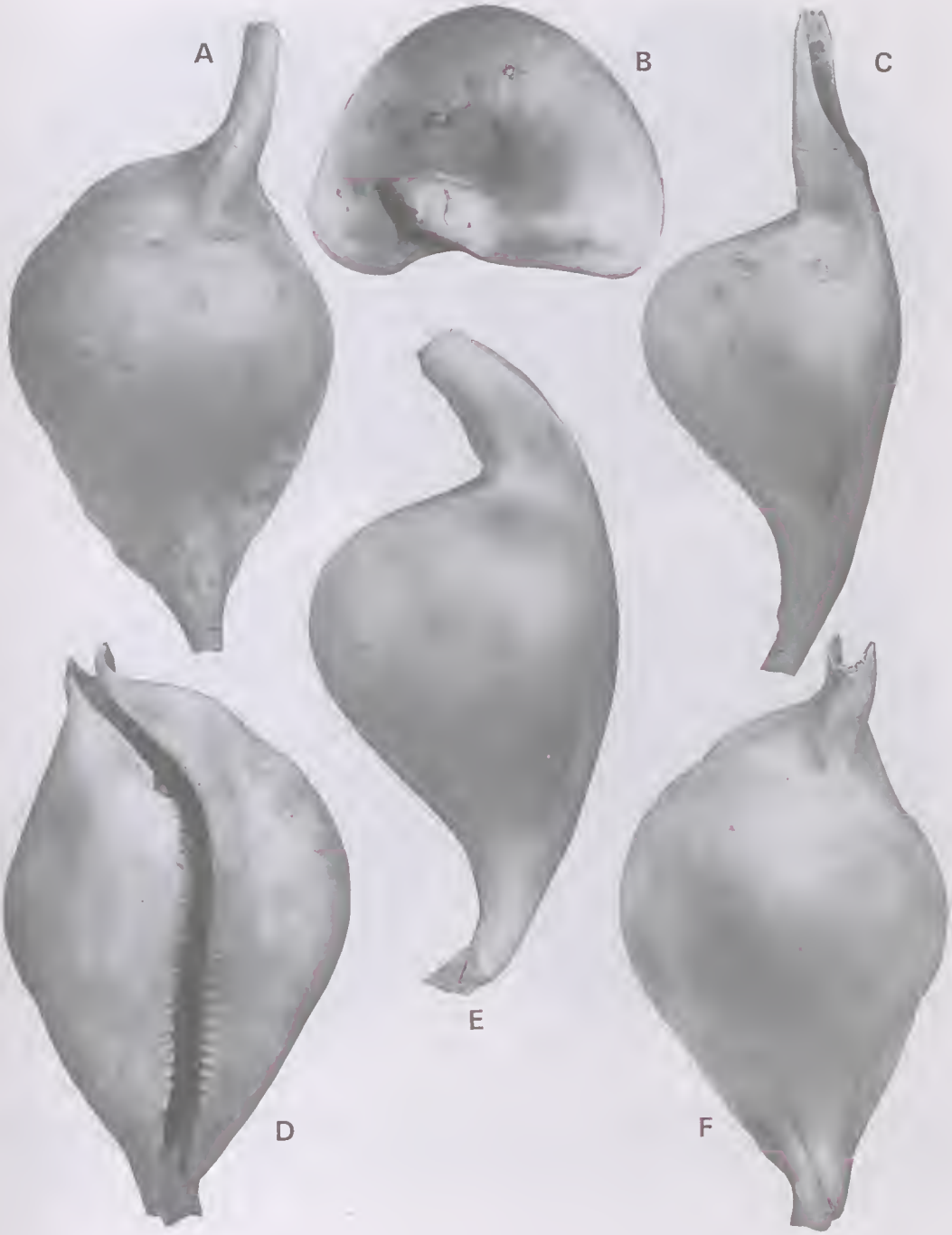

Figure 18. A–F, *Umbilia (U.) siphonata* (Chapman). A–C, P14835, Grices Creek, x 0.6. D–F, P12569, Muddy Creek, x 0.6, x 0.7, x 0.6.

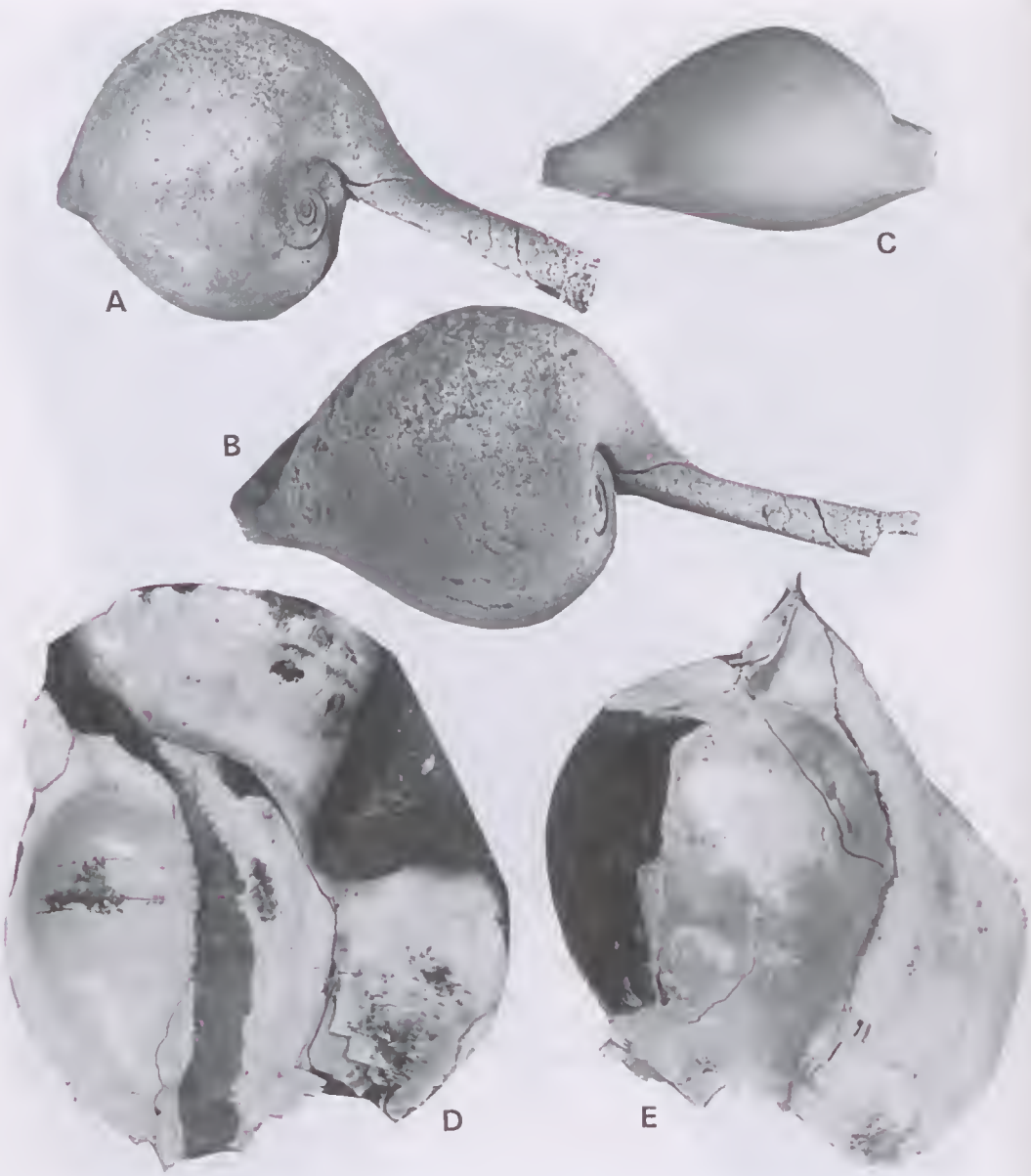

Figure 19. A–B, *Umbilia (U.) siphonata* (Chapman), P13243, holotype, Murray River cliffs near Waikerie, South Australia, x 0.7. C, *Umbilia (U.) hesitata* (Iredale), SAM T812B, syntype of *Cypraea tatei* Cossmann, Murray Desert, x 1.1. D–E, *Umbilia (Palliocypraea) gastroplax* (McCoy), P12140, holotype, between Mt Eliza and Mt Martha, x 0.8.

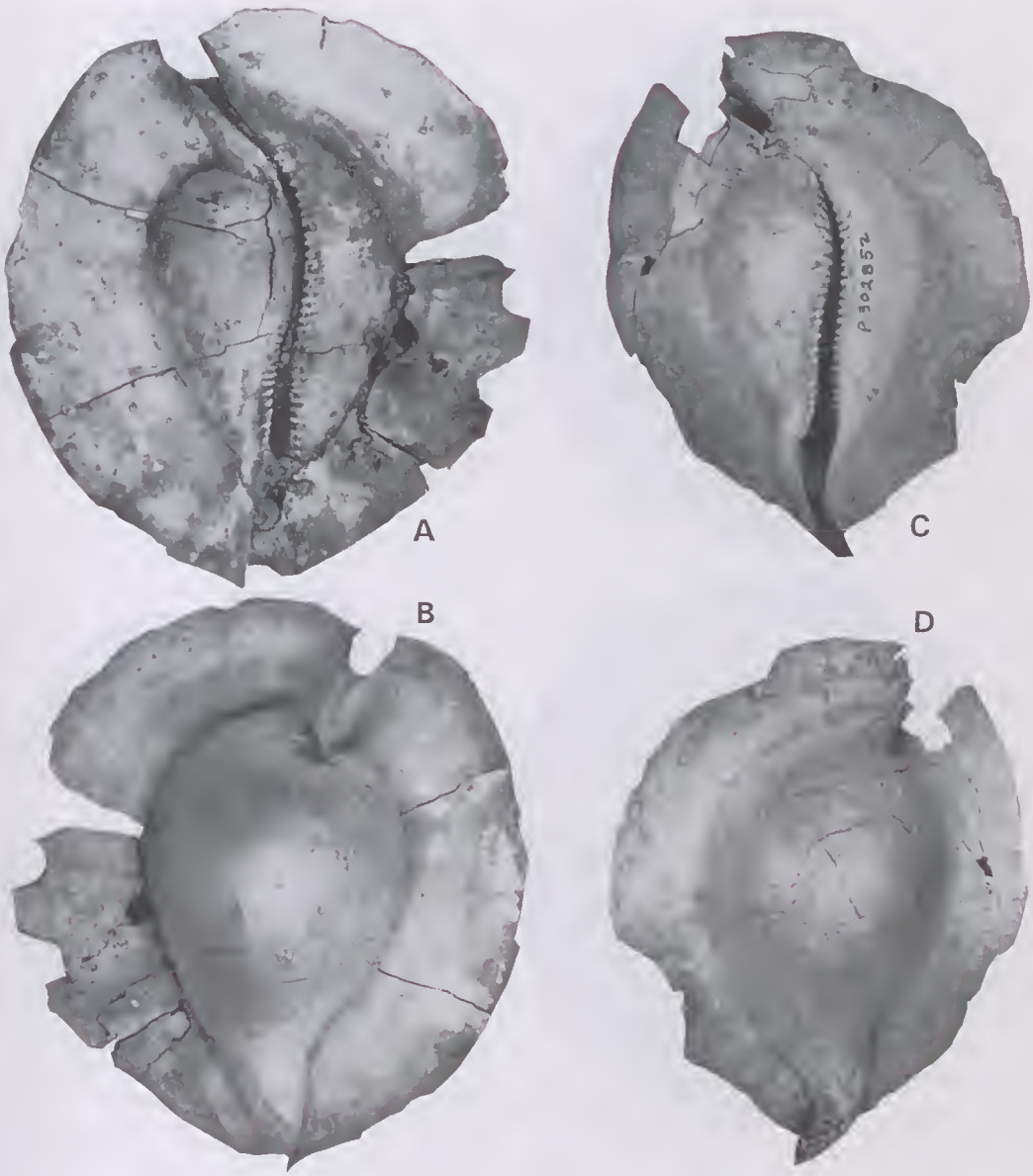

Figure 20. A–D, *Umbilia (Palliocypraea) gastroplax* (McCoy). A–B, P302854, Balcombe Bay, x 0.7. C–D, P302852, Clifton Bank, x 0.8.

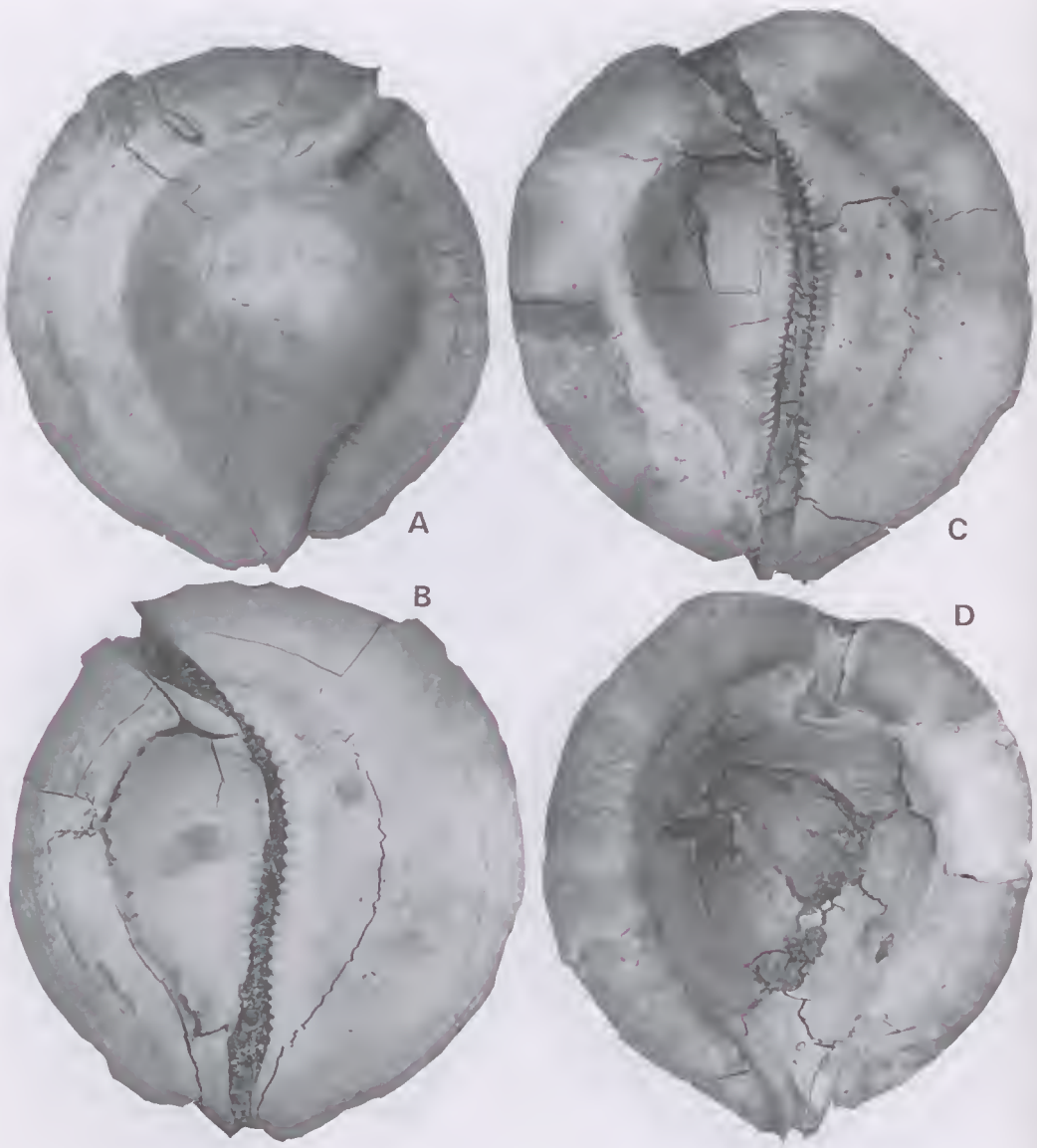

Figure 21. A–D, *Umbilia (Palliocypraea) gastroplax* (McCoy). A–B, P13373, Clifton Bank, x 0.8, C–D, P24869, Balcombe Bay, x 0.8, x 0.7.

Memoirs of the Museum of Victoria 59(2): 393–437 (2002)

THE AUSTRALIAN SPECIES OF *CHIMARRA* STEPHENS (TRICHOPTERA: PHILOPOTAMIDAE)

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Abstract

Cartwright, D.I., 2002. The Australian species of *Chimarra* Stephens (Trichoptera: Philopotamidae) *Memoirs of Museum Victoria* 59(2): 393–437.

Descriptions, keys and a checklist are provided for males of 26 species of the cosmopolitan caddisfly genus *Chimarra* (Philopotamidae), including 23 new species from Australia. Females of 22 species are also keyed and described.

Introduction

The widespread caddisfly genus *Chimarra* Stephens, 1829 is one of the largest genera in the order Trichoptera with about 400 species described, but with numbers of species approaching 600 with works in progress (Blahnik, 1997; Morse, 1999). The genus *Chimarra* is diverse, common and widespread in faster flowing areas of rivers and streams in Australia, although only four species have been described previously, *C. australis* Navas, 1923, *C. australica* Ulmer, 1916, *C. monticola* Kimmins, 1953 and *C. uranka* Mosely, 1953. In reference to *C. australis* Navas, described only from a female, Kimmins stated that he was "unable to recognize this species from the description" (Kimmins in Mosely and Kimmins, 1953: 404); and the whereabouts of the holotype female is unknown (Neboiss, 1988: 212). This species is not considered further in this paper.

Cartwright (1990) described and figured females of *C. australica* and *C. monticola* from Victoria. Wells (1991) partly figured four species of *Chimarra* in a key to Northern Territory (Alligator Rivers Region) Trichoptera. Wells and Cartwright (1993) listed four species of *Chimarra* amongst Trichoptera collected from Cape York Peninsula, north Queensland. Walker et al. (1995) listed nine species of *Chimarra*, including six undescribed species, from the Queensland Wet Tropics. Cartwright (1997) listed 24 *Chimarra* 'species' in a checklist, and noted that the only record of *Chimarra* from Tasmania was a of single male of *C. monticola*.

In this taxonomic revision of the Australian *Chimarra* nearly 9400 male and female specimens were examined and referred to 26 species. Half of these specimens belong to *C. uranka*, while another 20% were identified as *C. karakara* sp. nov. Distributions of Australian species are summarised in Table 1. The breakdown in distribution of Australian species in each province and region is: two (endemic) species recorded from the Eyrean province (Pilbara region of North Western Australia, N-WA); a total of 21 species recorded within the Torresian province of northern Australia, including seven species from the Kimberley region of N-WA, nine species from the northern part of the Northern Territory (N-NT), 11 species in northern Queensland (N-Qld); and five species in the Bassian province of southeastern Australia (SE-Qld, New South Wales, Victoria and Tasmania) (Table 1). *Chimarra* is recorded from all Australian states and territories except South Australia and the Australian Capital Territory and is also not recorded from southwestern Australia. Most of the *Chimarra* species described are from the warmer northern part or Torresian province of Australia. Neboiss and Wells (1998) found a similar preponderance of northern species in the Australian leptocerid genus *Triaenodes*, and suggested that *Triaenodes* may be a relatively recent arrival in Australia. *Chimarra* is well represented in the tropical and subtropical areas of Asia and Africa, and the genus as a whole can be described as warm adapted (Blahnik, 1998). The distribution of *Chimarra* differs from that of the other Australian philopotamid genus *Hydrobiosella* Tillyard, 1924, which is most common in southeastern Australia, particularly Tasmania and also occurs in southwestern Australia. The 'southern' distribution of *Hydrobiosella* is more indicative of an older Gondwanan origin.

Table 1. Eyrean (western-central), Torresian (northern) and Bassian (south-eastern) species of Australian *Chimarra*.

Eyrean species (Pilbara, northwestern WA)	
	C. luminaris, C. yoolumba
Torresian species (Kimberley, north-western WA, NT, northern Qld)	
	C. adaluma, C. akruna, C. bibaringa, C. bungoona, C. kaiya, C. karakara, C. larapinta, C. locolo, C. mouldsi, C. nabilla, C. natalicia, C. neboissi, C. orunbera, C. pillara, C. pita, C. ramka, C. stclairae, C. wooroonooran, C. yandala
Bassian species (southeastern Australia including Tasmania)	
	C. kewarra, C. monticola, C. tallawalla
Species common to both Bassian and Torresian provinces (eastern and northern Australia)	
	C. australica (mainly Bassian), *C. uranka* (mainly Torresian)

Ross (1956) and Blahnik (1997, 1998) have published studies on the phylogeny and biogeography of various groups and subgroups of *Chimarra*. Ross (1956) studied species of *Chimarra* from higher altitudes, although he noted that *Chimarra* is not primarily a montane group. He stated that from an Asiatic ancestor, a group spread throughout Asia and to Australia and Africa, where offshoot lines occur. Blahnik (1998) in a study of Neotropical *Chimarra*, suggested that New World *Chimarra* may represent a monophyletic group with several lineages, and that a phylogenetic analysis of Old World species is required to resolve unanswered questions. Blahnik (1998) postulated a common northern South America-Africa origin before continent separation to explain the Old and New World distribution of *Chimarra*.

Common but often variable key characteristics of the Australian fauna include: eastern Australian species with colour uniformly brown to almost black and northern Australian species with pale yellowish head, often with a brownish triangular area between the ocelli and darker wings and body; wings usually unicolorous, length of forewing in males 3.7–8.5 mm, females usually slightly larger; forewing commonly with Rs curved basal to discoidal cell, which often has an enlarged node or thickened veins; hindwing with or without fork 1, including at least one species where this character seems to be variable within the species; male genitalia with the ventral process on segment IX usually short, keel-like; tergum X usually mostly membranous mesally, not divided, with mesal or lateral lobes or processes; inferior appendages variable, usually short, in some species more elongate; phallus often with obvious embedded or projecting phallic or endotheeal spines; female genitalia usually short with segment VIII membranous dorsally; sternum IX with paired membranous or partly sclerotised plates; cerci usually short. Size, body and wing colour can be useful characters, but are variable. Colour should be considered with caution since the colour often fades with time in alcohol. The Australian species can be placed in groups based mainly on male genitalic characters. Some species are placed in groups which may be superficially similar but not necessarily natural or monophyletic. The groups can be characterised as follows: species with a 'pale window' (an area of semi-transparent membrane) in the wings – *C. luminaris* and *C. locolo*; species with hindwing with fork 1 present, relatively elongate inferior appendages and elongate lateral processes of tergum X usually with distinct 'barb-like projections' without apparent sensilla – *C. kaiya, C. bungoona, C. larapinta, C. orunbera, C. pillara* and *C. yandala*; species with a relatively elongate ventral process projecting between bases of the inferior appendages – *C. natalicia* and *C. neboissi*; species with a single large dorsal phallic projection or apicodorsal extension of the phallotheca – *C. ramka* and *C. uranka*; species with a pair of elongate phallic spines – *C. tallawalla* and *C. wooroonooran*; species with one or two pairs of pigmented mesal processes on tergum X (and/or tergum IX) and dorsal sclerotised 'hood-like' projection on the phallus – *C. adaluma, C. yoolumba, C. nabilla, C. akruna* and *C. pita*; uniformly dark species without the above characters but with relatively slender upturned inferior appendages – *C. monticola, C. australica* and *C. kewarra*; and the rest (probably not a natural group), again darker species typically with shorter inferior appendages – *C. mouldsi, C. bibaringa, C. karakara* and *C. stclairae*.

Most of the material studied was made available by Dr Arturs Neboiss. Depositories for specimens are abbreviated as follows: Museum Victoria, Melbourne (NMV), Australian National Insect Collection, Canberra (ANIC), the Natural History Museum, London (BMNH),

Naturhistoriska Riksmuseet, Stockholm (NRS), Museum and Art Galleries of the Northern Territory, Darwin (NTM) and the Queensland Museum, Brisbane (QM). All specimens, including types, mentioned in the text are lodged in the NMV unless stated otherwise.

Males and females of each species are most readily distinguished by genitalic features, often requiring clearing of the abdomen in potassium hydroxide. Females were paired with respective males on the basis of similarities in coloration, particularly on the head, and on wing venation and locality and some were associated by rearing out from larvae or pupae.

Figured specimens are identified by the notebook numbers of Dr Arturs Neboiss (NMV), prefix PT-; or the author; prefix CT-. Terminology used generally follows that of Nielsen (1957, 1981), and Blahnik (1998). Abbreviations for genitalic parts are indicated on Figs 2–4 (male) and 80–81 (female) and additionally where necessary. Typically, setae or spines are illustrated only on the right side of the figure (as viewed) to enable a better view of the underlying structures.

Names of prolific collectors have been abbreviated in the text as follows: J.E.Bishop – JEB; J. Blyth – JB; P. Dostine – PD, M.S. Moulds – MSM; A. Neboiss – AN; P. Suter – PS; A. Wells – AW.

Chimarra Stephens

Chimarra Stephens, 1829: 318.—Mosely and Kimmins, 1953: 398.

Type species. Phryganea marginata C. Linnaeus, 1767, by monotypy.

Diagnosis. A revised diagnosis of the genus *Chimarra* was provided recently by Blahnik (1998: 14).

Key to males and females of species of *Chimarra* from Australia

1. Males 2
— Females 27
2. Forewing with 'pale window' (Figs 1, 1a) ..... '*C. luminaris*-group' ... 3
— Forewing without 'pale window' 4
3. Inferior appendages in lateral view, sub-rectangular, not tapered apically (Fig. 2); hindwing without 'pale window' (Fig. 1) N-WA (Pilbara) ..... *C. luminaris*
— Inferior appendages in lateral view, not subrectangular, tapered apically (Fig. 5); hindwing with 'pale window' (Fig. 1a) N-NT ..... *C. locolo*
4. Hindwing usually with fork 1 present; lateral processes of tergum X elongate, usually with at least 1 'barb-like projection', usually longer than inferior appendages; inferior appendages relatively long with small digitiform projection apically (Figs 8, 11, 17) ..... '*C. kaiya*-group' ... 5
— Hindwing usually with fork 1 absent; lateral processes of tergum X , if present, usually short without 'barb-like projections', usually shorter than inferior appendages; inferior appendages usually short, robust (Figs 26, 35) 10
5. Mesal process of tergum X single in dorsal view (Figs 10, 13, 16, 19) 6
— Mesal processes of tergum X paired in dorsal view (Figs 22, 25) 8
6. Inferior appendages, in lateral view, angled strongly near midventral margin; lateral processes of tergum X with 2 small subapical 'barb-like projections' (Figs 8, 10) N-NT, N-Qld ..... *C. kaiya*
— Inferior appendages, in lateral view, not angled strongly near mid ventral margin; lateral processes of tergum X without or with 1 subapical 'barb-like projection' or only weakly developed (Figs 11, 13, 14, 16, 17, 19) 7
7. Phallus with pair of projecting endotheeal spines obvious dorsally (Fig. 13); lateral processes of tergum X with relatively large apical hook and subapical 'barb-like projection' (Figs 11, 13) N-NT ..... *C. bungoona*
— Phallus without pair of projecting endotheeal spines apparent dorsally (Figs 16, 19); lateral processes of tergum X without relatively large apical hook or 'barb-like projections', paired processes not apparent or only weakly developed (Figs 14, 16, 17, 19) 8

8. Lateral processes of tergum X with paired processes weakly developed and without dorsal branch (Figs 14, 16); hindwing with fork 1 present, N-WA.... ..... *C. larapinta*

— Lateral processes of tergum X without paired processes but with distinctive dorsal branch (Figs 17, 19); hindwing with fork 1 absent, N-WA..... ..... *C. orumbera*

9. Lateral processes of tergum X with relatively large upturned apical hook (Fig. 20); paired mesal processes of tergum X relatively short (Fig. 22) N-WA ..... *C. pillara*

— Lateral processes of tergum X without upturned apical hook (Fig. 23); paired mesal processes of tergum X relatively long (Fig. 25) N-Qld..... ..... *C. yandala*

10. Ventral process of segment IX relatively elongate, acute, projecting between bases of inferior appendages (Figs 26, 27, 29, 30)....'*C. natalicia*-group'... 11

— Ventral process of segment IX relatively short, obtuse, not projecting between bases of inferior appendages (Figs 32, 33, 35, 36) 12

11. Inferior appendages in ventral view, with digitiform apical mesal projection, narrowly separated from the subapical angle, forming a deep notch (Fig. 27) N-Qld..... *C. natalicia*

— Inferior appendages in ventral view, without digitiform apical mesal projection, but with basal mesal projection widely separated from the apical angle, forming a wide notch (Fig. 30) N-Qld..... *C. neboissi*

12. Phallus with a single projecting, elongate, dorsal 'phallic projection' or 'apicodorsal extension of the phallotheca' (Figs 32, 32a, 34, 35, 35a, 37)..... ..... '*C. uranka*-group'...13

— Phallus with paired projecting 'phallic spines' or spines not apparent (Figs 38, 38a, 40, 41, 41a, 43).....14

13. Mesal processes of tergum X relatively short, not reaching apex of dorsal 'phallic projection' (Figs 32, 34) Qld, N-NT, N-WA ..... *C. uranka*

— Mesal processes of tergum X relatively long, reaching apex of dorsal 'phallic projection' (Figs 35, 37) N-NT..... *C. ranuka*

14. Phallus with paired long and slender 'phallic spines' (Figs 38, 38a, 41, 41a) ..... '*C. tallawalla*-group'...15

— Phallus without paired projecting long and slender 'phallic spines' apparent, single to many endothecal spines may be present (Figs 44, 50) 15

15. Phallus with paired very slender, very elongate 'phallic spines' dorsally, attached near base of phallotheca, often extending past apex of phallus (Figs 38–40, 38a), although sometimes withdrawn and so not as apparent (Figs 38b, 40a) E-NSW, SE-Qld ..... *C. tallawalla*

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Chimarra luminaris-group

The *C. luminaris*-group of two species, *C. luminaris* and *C. locolo*, is characterised primarily by forewings with 'pale window' near discoidal cell. Other common but not exclusive characters are pale head and brownish body and wings, hindwing with fork 1 absent, forewing with vein Rs thickened and curved slightly basal to discoidal cell; male genitalia tergum X with a pair of relatively widely separated mesal processes, phallus with large, protruding ventral or apical spine(s), ventral process on segment IX small and keel-like; female genitalia relatively short and broad. Both members of this group are from northern Australia, one each from N-WA and N-NT.

Chimarra luminaris sp. nov.

Figures 1–4, 80, 81

Chimarra sp. nov. CT-262.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, Fortescue R., Millstream, S of Roebourne, 22 Feb 1977, M.S. and B.J. Moulds (NMV, T-17548). Paratypes. 24 males (specimen CT-262 figured), 15 females (specimen CT-263 figured), collected with holotype (NMV).

Other material examined. Western Australia. 9 males, 2 females, Lockyer Gorge, Harding R., Pilbara, 19 Oct 1979, JB; 24 males, 12 females, Millstream, 21–22 Apr 1972, N.R. Mitchell (ANIC); 1 male, 1 female, Fortescue R., Millstream National Park, 21°34′S, 117°03′E, 24–25 Apr 1992, P.S. Cranston; 16 males, 16 females, Fortescue R., Millstream, S of Roebourne, 22 Feb 1977, M.S. and B.J. Moulds; 7 males, 6 females, Crossing Pool, Millstream, Pilbara, 21 Oct 1979, JB; 2 male pupae, Pilbara, Ashburton R., Wallbrook Pool, 22°28.54′S, 116°28.05′E, date?, P. Cranston (ANIC); 2 males, 1 female, 28 km NE Tom Price, 22°30′S, 117°58′E, 26 Sep 1995, D.C.F. Rentz and J. Otto (ANIC); 7 males, 3 females, Wittenoom Gorge, Hamersley Range National Park, 20 Feb 1977, M.S. and B.J. Moulds; 6 males, 1 female, Fortescue Falls, Hamersley Range National Park, 27 Oct 1979, JB; 1 male, Hamersley National Park, Forteseue Falls, 23°38′S, 118°33′E, 23 Apr 1992, Cranston and Gullan (ANIC).

Diagnosis. Chimarra luminaris resembles *C. locolo* in possessing 'pale semi-transparent window' in the forewing, but it is distinguished by the absence of the 'pale window' in the hindwing.

Description. Head pale, body and wings brownish to dark brown, forewings with 'pale semi-transparent window' near discoidal cell; hindwings without 'pale window'; length of forewing: male 5.0–5.4 mm, female 5.3–7.1 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present; in forewing, vein Rs thickened and curved slightly basal to discoidal cell (Fig. 1).

Male. Ventral process on segment IX small, keel-like; inferior appendages short, in lateral view subrectangular, length about 1.5 times width (Fig. 2), apices slightly inflexed; mesal processes of tergum X short, usually with bifid apices, sometimes asymmetrical; lateral processes of tergum X with 3 small apical lobes; phallus with robust hooked endotheeal spine projecting at apex and with dorsal sclerotised 'hood-like' projection (Figs 2–4).

Female. Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with dark sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively widely separated, with connecting posterior margin of segment VIII fairly straight and without notches. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of faint, oblong pigmented areas and laterally with distinctive pairs of knob-like processes. Tergum X forming 2 lobes with numerous setae, each with short apical cercus (Figs 80, 81).

Etymology. Luminaris – Latin for window (wings).

Remarks. Chimarra luminaris has been collected from five sites in the Pilbara region of northern Western Australia (latitudinal range 21°00′–23°38′S).

Chimarra locolo sp. nov.

Figures 1a, 5–7, 82, 83

Chimarra sp. nov. E .—Cartwright, 1997: 17.

Type material. Holotype male, Northern Territory, Litchfield National Park, UV light, 6 Jun 1991, Wells and Webber (NMV, T-17588). Paratypes. 21 males (specimen CT-279 figured), 22 females (specimen CT-299 figured), collected with holotype (NMV, NTM).

Other material examined. Northern Territory. 1 female, Jim Jim Ck, 3 km below falls, Kakadu National Park, 1 Sep 1979, JB; 1 male, Berry Springs, 12°42′S, 130°58′E, 7 May 1992, A.W. (NTM); 3 males, 2 females, Florence Falls, Litchfield National Park, MV lt, 9 Apr 1991, Horak and Wells (NTM); 7 males, 13 females, Litchfield Park, MV light, 3 Apr 1991, J. Webber and R. De Jong (NTM); 1 male, Devil Devil Ck, 70 km SW Daly R. Mission, 23 Aug 1979, JB; 1 male, Katherine R. Gorge National Park, 26 Jan 1977, M.S. and B.J. Moulds.

Diagnosis. Chimarra locolo resembles *C. luminaris* in possessing 'pale semi-transparent window' in the forewing, but it is distinguished by the presence of the 'pale window' in the hindwing.

Description. Head pale, with brown triangular area between ocelli, body and wings brownish, fore- and hindwings with 'pale window' centred near discoidal cell; length of forewing: male 4.7–5.2 mm, female 4.9–6.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present: in forewing, vein Rs thickened and curved slightly basal to discoidal cell (Fig.1a).

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, broadbased, narrowing strongly at about middle to slender apices (Fig. 5); mesal pair of processes of tergum X and IX margin slender, widely spaced (Fig. 7); phallus robust with asymmetrical pair of strong, serrate-edged endothecal spines projecting ventrally (Fig. 6).

Female. Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with dark selerites and associated setae dorsally, near middle and ventrally. Ventral pair of selerites relatively narrowly separated, with connecting posterior margin of segment VIII fairly straight and without notches. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of faint, oblong pigmented areas. Tergum X comprising 2 setose lobes with numerous setae, each with short apical cereus (Figs 82, 83).

Etymology. Locolo – Northern Territory Aboriginal word for circle (wings).

Remarks. This species has been collected from the northern half of the Northern Territory (latitudinal range 12°42′–14°29′S).

Chimarra kaiya-group

The *C. kaiya*-group of six species, *C. kaiya, C. bungoona, C. larapinta, C. orumbera, C. pillara* and *C. yandala*, is characterised primarily by male genitalia with inferior appendages elongate and slender with an apical finger-like process, tergum X with elongate lateral processes, often with 'barb-like projections'; female genitalia in all but one species (*C. kaiya*) relatively elongate with pigmented cerci. Other common but not exclusive characters are pale head and brownish body and wings, wings unicolorous, hindwing with fork 1 present (except *C. orumbera*), forewing with vein Rs thickened and curved slightly basal to discoidal cell, male genitalia with tergum X either with a pair of mesal processes or single mesal process, phallus with large, often protruding spine(s), ventral process on segment IX small and keel-like. All members are from northern Australia.

Chimarra kaiya sp. nov.

Figures 8–10, 86, 87

Chimarra sp. C.—Wells, 1991: 20.

Chimarra sp. n. C.—Wells and Cartwright, 1993: 227.

Chimarra sp. nov. CT-270.—Cartwright, 1997: 17.

Type material. Holotype male, Northern Territory, ARRS Radon Springs, lt tr., 13–14 Apr 1988, AW and PS (NMV, T-17632). Paratypes. 21 males (specimen CT-270 figured), 6 females (specimen CT-297 figured), collected with holotype (NMV).

Other material examined. Northern Territory, Kakadu National Park–Radon Springs, Baroalba Springs, Koongarra, 15 km E of Mt Cahill, Stag Ck at BHP camp, Jim Jim Falls campsite, Litchfield National Park–Walker Ck, Ada Ck (ANIC, NTM, NMV).

Queensland. Cape York Peninsula–Lockerbie Scrub, Jardine R., Heathlands area, Iron Range, McIlwraith Range, Mt Webb National Park (ANIC, NMV, QM).

Diagnosis. In general form of male genitalia, *C. kaiya* resembles others in the group, but it is distinguished by the strongly angled inferior appendages and the lateral processes of tergum X with 2 subapical 'barb-like projections' and no apical hook.

Description. Head pale, body and wings brownish; length of forewing: male 4.7–6.1 mm, female

5.0–6.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present; in forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view long, length about 3.5 times width, angled strongly near middle of ventral margin, with small digitiform process apically (Fig. 8); single mesal process of tergum X short, simple in lateral view (Fig. 10); lateral processes of tergum X longer than inferior appendages, with 2 small dorsal 'barb-like projections' subapically and towards middle, no apical hook; phallus robust with 2 long slightly curved endothecal spines projecting at apex (Figs 8, 9).

Female. Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with dark sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII fairly straight and without notches. Segment VIII dorsally with a membranous area almost dividing segment. Ninth sternum without any pigmented areas. Tergum X forming 2 lobes with numerous setae, each with a short, pigmented apical cercus (Figs 86, 87).

Etymology. Kaiya – Queensland Aboriginal word for spear with two barbs (lateral processes on tergum X).

Remarks. This is a common and widespread species across Cape York Peninsula and northern Northern Territory (latitudinal range 10°46′–15°14′S).

Chimarra bungoona sp. nov.

Figures 11–13, 88, 89

Chimarra sp. D.—Wells, 1991: 20.
Chimarra sp. nov. CT-272.—Cartwright, 1997: 17.

Type material. Holotype male, Northern Territory, Radon Springs, lt tr., 14 Apr 1989, AW and PS (NMV, T-17660). Paratypes. 1 male (CT-272, drawn specimen), Randon (Radon?) Ck, Kakadu National Park, 3 Sep 1979, JB (NMV); 2 females (specimen CT-298 figured), ARRS Radon Springs, lt tr., 18–19 May 1988, AW and PS (NMV).

Other material examined. Northern Territory, 1 male, ARRS Radon Springs, lt tr., 13–14 Apr 1988, AW and PS? (NTM); 2 males, Koongarra, 15 km E of Mt Cahill, 12°52′S, 132°50′E, 12–13 Jun 1973, J.C. Cardale (ANIC); 2 males, Litchfield National Park, Walker Ck, UV lt, 18–19 Apr 1992, AW (NTM); 1 male, Litchfield National Park, Ada Ck at jump up, lt tr, 24–25 Jun 1992, Wells and Webber (NTM); 2 males, Umbrawarra Gorge, 14°00′S, 131°38′E, MV lt, 23 Aug 1982, J. and I. Archibald (ANIC).

Diagnosis. This species closely resembles others in the group in general form of male genitalia, but it is distinguished by the combination of a single mesal process on tergum X and lateral processes of tergum X with subapical 'barb-like projection' and apical hook.

Description. Head pale with brown triangular area between ocelli, body and wings brownish; length of forewing: male 4.9–5.2 mm, female 4.9–6.3 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present; in forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view long, length about 3.5 times width, not angled strongly near middle of ventral margin, with small digitiform process apically (Figs 11, 12); single mesal process of tergum X short, slender (Fig. 13), simple in lateral view; lateral processes of tergum X longer than inferior appendages, with relatively large dorsal 'barb-like projection' subapically and apical hook; phallus robust with pair of endothecal spines projecting dorsally and a single spine projecting apically (Figs 11, 13).

Female. Female genitalia relatively long, elongate; sternum VII with small keel-like process. Posterolateral margin of segment VIII with dark sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII fairly straight and with small notch. Segment VIII dorsally with a membranous area almost dividing segment. Ninth sternum without any pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively long, pigmented apical cercus (Figs 88, 89).

Etymology. Bungoona – Australian Aboriginal word for sandy creek (typical habitat).

Remarks. Chimarra bungoona is known from five sites in the northern Northern Territory (latitudinal range 12°45′–14°00′S).

Chimarra larapinta sp. nov.

Figures 14–16

Chimarra sp. nov. U.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, 'Marun' CALM site 8/4, Prince Frederick Harbour, 15°00′S, 125°21′E, at light, 6–11 Jun 1988, I.D.

Naumann (ANIC). Paratype. 1 male (specimen CT-308 figured), collected with holotype (ANIC).

Other material examined. Western Australia. 1 male, nr Mitchell Plateau airfield, 14°48′S, 125°49′E, at light, 15 May 1983, J.C. Cardale (ANIC); 2 males, 1 female, Carson Escarpment, 14°49′S, 126°49′E, Drysdale 1975 Survey site B1, 9–15 Aug 1975, I.F.B. Common and M.S. Upton (ANIC); 1 male (specimen CT-289, genitalia missing), 'Marun' CALM site 8/4, Prince Frederick Harbour, 15°00′S, 125°21′E, at light, 6–11 Jun 1988, I.D. Naumann (ANIC); 7 males, CALM site 28/3, 4 km W of King Cascade, 15°35′S, 128°15′E, 17–20 Jun 1988, T.A. Weir (ANIC).

Diagnosis. Chimarra larapiuta closely resembles others in the group in general form of male genitalia, but it is distinguished by the combination of a single mesal process on tergum X and lateral processes of tergum X with paired subapical 'projections' only weakly developed.

Description. Head, body and wings pale; length of forewing: male 4.6–4.9 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present: in forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, long, length about 3.5 times width, slightly narrowed but not angled strongly near middle of ventral margin, with small digitiform process dorsoapically (Figs 14, 16); single mesal process of tergum X short, triangular (Fig. 16), simple in lateral view (Fig. 14); lateral processes of tergum X longer than inferior appendages, with paired subapical projections weakly developed laterally (Fig. 16); phallus robust with short curved ventral endothecal spine visible subapically (Figs 14, 15).

Female unknown.

Etymology. Larapiuta – Australian Aboriginal word for flowing water (typical habitat).

Remarks. This species has been collected from four sites in the Kimberley region of northern Western Australia (latitudinal range 14°48′–15°35′S).

Chimarra orumbera sp. nov.

Figures 17–19, 84, 85

Chimarra sp. nov. CT-266.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, Kimberley, Prince Regent R., 15°47′S, 125°24′E, May 1985, E. Bloomfield (NMV, T-17664). Paratypes. Western Australia. 5 males, collected with holotype (NMV); 1 male (specimen CT-266 figured), Barnett R. Gorge, Barnett Station, Kimberley, 1 Oct 1979, J.B. (NMV); 2 males, same data (NMV); 1 male, 1 female (specimen CT-316 figured), Manning R. nr Mt Barnett, 16°40′S, 125°56′E, 8 Sep 1996, I. Edwards (NMV); 1 female, Mitchell Plateau, Lone Dingo Ck, trib. of Mitchell R., 17 Feb 1979, J.E.B. (NMV).

Other material examined. Western Australia. 2 males, 1 female, CALM site 13/4, 12 km S of Kalumburu Mission, 14°25′S, 126°38′E, 7–11 Jun 1988, T.A. Weir (ANIC); 1 male, 'Marun' CALM site 8/4, Prince Frederick Harbour, 15°00′S, 125°21′E, at light, 6–11 Jun 1988, I.D. Naumann (ANIC); 11 males, CALM site 28/3, 4 km W of King Cascade, 15°35′S, 128°15′E, 17–20 Jun 1988, T.A. Weir (ANIC); 1 male, El Questro Station, Chamberlain R. pool, 15°58′S, 127°56′E, 26 Aug 1996, I. Edwards; 2 males, Backsten Ck, S of Prince Regent Reserve, 16°00′S, 125°29′E, 6 Sep 1996, I. Edwards; 1 female, Drysdale R. headwaters, 30 km NW Mt Elizabeth HS, 30 Sep 1979, JB; 4 males, 1 female, Drysdale R., upper reaches, 16°09′S, 125°58′E, 7 Sep 1996, I. Edwards; 1 male, 1 female, Adcock Gorge, Gibb R.-Derby Rd, Kimberley, 2 Oct 1979, JB; 1 male, Bell Gorge, Melaleuka Hole, 17°01′S, 125°14′E, 13 Sep 1996, I. Edwards; 1 female, King Edward R., 14°54′S, 126°12′E, 3 Sep 1996, I. Edwards.

Diagnosis. Chimarra orumbera is distinguished in the group by the absence of both fork 1 on the hindwing and 'barb-like projections' on the lateral processes of tergum X. The lateral processes of tergum X have a distinctive dorsal branch.

Description. Head pale yellow with brown triangular area between ocelli, body brown, wings dark brown; length of forewing: male 3.7–4.7 mm, female 4.2–5.0 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present: in forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, long, length about 3.0 times width, slightly narrowed but not angled strongly near middle of ventral margin, with small digitiform process apically (Fig. 17); mesal process of tergum X broad (Fig. 19), simple in lateral view (Fig. 17); lateral processes of tergum X with dorsal branch joined basally, ventral branch about as long as inferior appendages, slightly laterally flattened, without 'barb-like projections', dorsal branch slightly shorter and more slender (Figs 17, 19); phallus robust with long endothecal spine embedded subapically (Figs 18, 19).

Female. Female genitalia relatively long, elongate; sternum VII with keel-like process. Posterolateral margin of segment VIII with dark selerites and associated setae dorsally, near middle and ventrally. Ventral pair of selerites relatively narrowly separated, with connecting posterior

margin of segment VIII fairly straight and without small noteh. Segment VIII dorsally with a membranous area almost dividing segment. Ninth sternum without any pigmented areas. Tergum X forming 2 lobes with numerous setae, eaeh with relatively long, pigmented apieal eereus (Figs 84, 85).

Etymology. Orumbera – Australian Aboriginal word for large spear (genitalia).

Remarks. Chimarra orumbera is known only from the Kimberley region of northern Western Australia (latitudinal range 14°25′–17°01′S).

Chimarra pillara sp. nov.

Figures 20–22, 92, 93

Chimarra sp. nov. T.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, 'The Crusher' CALM site 9/1, 4 km S by W mining eamp, Mitehell Plateau, 14°52′S, 125°50′E, 2–6 Jun 1988, I.D. Naumann (ANIC). Paratypes. Western Australia. 4 males, 10 km W by N of mining eamp, Mitchell Plateau, 14°45′S, 125°47′E, at light, 11 May 1983, J.C. Cardale (ANIC); 4 males, 1 female, nr Mitchell Plateau airfield, 14°48′S, 125°49′E, at light, 15 May 1983, J.C. Cardale (ANIC); 1 male (speeimen CT-288 figured), 1 female (speeimen CT-327 figured) 'Marun' CALM site 8/4, Prinee Frederiek Harbour, 15°00′S, 125°21′E, at light, 6–11 Jun 1988, I.D. Naumann (ANIC); 1 male ,1 female, Mining eamp, Mitchell Plateau, 14°49′S, 125°50′E, 9–19 May 1983, I.D. Naumann and J.C. Cardale (ANIC); 1 male, 2 females, 4 km S by W mining eamp, Mitehell Plateau, at light, 14°52′S, 125°50′E, 13 May 1983, J.C. Cardale (ANIC); 1 male, 'The Crusher' CALM site 9/1, 4 km S by W mining eamp, Mitchell Plateau, 14°52′S, 125°50′E, 2–6 Jun 1988, I.D. Naumann (ANIC); 1 male, Augustus Island, CALM site 26/1, 15°25′S, 124°38′E, 11–16 Jun 1988, I.D. Naumann (ANIC); 3 males, 1 female, CALM site 25/1, Synnot Ck, 16°31′S, 125°16′E, 17–20 Jun 1988, T.A. Weir (ANIC).

Other material examined. Northern Territory. 1 male, 8 females (speeimen CT-327 figured), Litchfield Park, MV light, 3 Apr 1991, J. Webber and R. De Jong (NTM); 1 male, 7 females, Litehfield National Park, UV light, 6 Jun 1991, Wells and Webber (NTM).

Diagnosis. This species is distinguished from others in the group by the eombination of relatively short paired mesal proeesses on tergum X and the lateral proeesses of tergum X with subapical 'barb-like projeetions' and well developed apieal hook.

Description. Head, body and wings pale; length of forewing: male 4.6–5.2 mm, female 5.2–5.6 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present: in forewing, vein Rs thiekened and eurved slightly basal to diseoidal eell.

Male. Ventral proeess on segment IX small, keel-like; inferior appendages in lateral view, long, length about 3.5 times width, not angled strongly near middle of ventral margin, with small digitiform proeess apieally (Figs 20, 21); pair of mesal proeesses of tergum X short (Fig. 22), simple in lateral view (Fig. 20); lateral proeesses of tergum X longer than inferior appendages, slightly laterally flattened, with relatively large 'barb-like projeetion' subapieally and large apieal hook (Figs 20, 22); phallus long with pair of robust endotheeal spines visible dorsally (Figs 20, 22).

Female. Female genitalia relatively long, elongate; sternum VII with a keel-like proeess. Posterolateral margin of segment VIII with dark selerites and assoeiated setae dorsally, near middle and ventrally. Ventral pair of selerites relatively narrowly separated, with eonneeting posterior margin of segment VIII with small noteh. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without any pigmented areas, posterior margin with angular 'eorners'. Tergum X forming 2 lobes with numerous setae, eaeh with relatively long, pigmented apieal eereus (Figs 92, 93).

Etymology. Pillara – Aboriginal word for spear with two barbs (lateral proeesses on tergum X).

Remarks. This speeies is known from the Kimberley region of northern Western Australia and Litehfield National Park in the Northern Territory (latitudinal range 14°45′–16°31′S). It has been collected from April to June.

Chimarra yandala sp. nov.

Figures 23–25, 90, 91

Chimarra sp. n. G.—Wells and Cartwright, 1993: 227.

Chimarra sp. nov. CT-271.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Gordon Ck, Iron Range, 16 Apr 1975, Moulds (NMV, T-17676). Paratypes. 1 male (specimen CT-271 figured) same loeality, 10 Jun 1975, MSM (NMV); 2 males, 3 females, same loeality, 12 May 1975, MSM (NMV); 1 male, 1 female (specimen CT-301 figured) , same loeality, 18 Apr 1975, Moulds (NMV); 2 females, Gordon Ck, Iron Range, 2 Jun 1975, MSM (NMV).

Other material examined. Queensland. 1 male, 1 female, Burster Ck, 10°55′S, 142°40′E, at light, 17 Oct 1992, P. Zborowski and T. Weir (ANIC); 1 male, Canal Ck u/s jn Eliot Ck, UV lt, 11°23′S, 142°25′E, 6 Feb 1992, Cartwright and Wells (QM); 2 females, Canal Ck u/s jn Eliot Ck, UV lt, 11°23′S, 142°25′E, 6 Feb 1992,

Cartwright and Wells (QM); 1 female, Dulhunty R., Telegraph Crossing, 11°50′S, 142°30′E, 10 Feb 1992, Cartwright and Wells (QM); 1 male, 14 km ENE Heathlands, by hand, rainforest, 11°41′S, 142°42′E, 28 Feb 1993, P. Zborowski (ANIC); 1 male, Dividing Range, 25 km W of Capt Billy Landing, 11°40′S, 142°45′E, 4–9 Jul 1975, G.R. Monteith (ANIC); 1 male, 9 km ENE Mt Tozer, MV lt, 12°43′S, 143°17′E, 5–10 Jul 1986, J.C. Cardale (ANIC); 1 male, 2 females, Middle Claudie R., Iron Range, 2–9 Oct 1974, Moulds; 1 male, Archer R. crossing, Cape York Peninsula, 9 Sep 1974, MSM; 4 males, 3 km NE Mt Webb, 15°03′S, 145°09′E, 1–3 Oct 1980, J.C. Cardale (ANIC); 1 male, 7 km N of Hopevale Mission, 15°14′S, 145°07′E, 4 Oct 1980, J.C. Cardale (ANIC); 5 males, 1 km N of Rounded Hill nr Hopevale Mission, 15°17′S, 145°13′E, 5–6 Oct 1980, J.C. Cardale (ANIC); 1 male, 5 km W by N of Rounded Hill nr Hopevale Mission, 15°17′S, 145°10′E, 7 Oct 1980, J.C. Cardale (ANIC); 1 male, same locality, 15°17′S, 145°10′E, 7 Oct 1980, D.H. Colless (ANIC); 3 males, Mt Cook National Park, Cooktown, 15°29′S, 145°16′E, 11–12 Oct 1980, J.C. Cardale (ANIC).

Diagnosis. Chimarra yandala is distinguished from others in the group by the combination of paired mesal processes on tergum X and the elongate and slender lateral processes of tergum X with one subapical 'barb-like projection'.

Description. Head pale with brown triangular area between ocelli, body and wings brownish; length of forewing: male 5.0–5.4 mm, female 4.9–6.2 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present; in forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, long, length about 3.5 times width, not angled strongly near middle of ventral margin, with small digitiform process apically (Figs 23, 25); pair of mesal processes of tergum X relatively long (Fig. 25), simple in lateral view (Fig. 23); lateral processes of tergum X longer than inferior appendages, slender, with 1 relatively small 'barb-like projection' subapically (Figs 24, 25); phallus with short, robust endothecal spine visible on dorsal margin subapically (Figs 23, 25).

Female. Female genitalia relatively long, elongate; sternum VII with elongate keel- like process. Posterolateral margin of segment VIII with sclerites and associated setae near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII with small notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without pigmented areas, posterior margin with rounded 'corners'. Tergum X forming 2 lobes with numerous setae, each with relatively long, pigmented apical cereus (Figs 90, 91).

Etymology. Yandala – Queensland Aboriginal word for spear with long point (lateral processes on tergum X).

Remarks. This appears to be a common species on Cape York Peninsula, north-eastern Queensland (latitudinal range 10°55′–15°29′S).

Chimarra natalicia-group

The *C. natalicia*-group of two species, *C. natalicia* and *C. neboissi*, both characterised primarily by male genitalia with ventral process on segment IX which is relatively elongate and acute. Other common but not exclusive characters are dark head, body and wings, wings unicolorous, forewing with vein Rs thickened and curved slightly basal to discoidal cell, male genitalia with tergum X without any apparent mesal processes but with short, broad lateral processes, phallus with more than one endothecal spine, inferior appendages short; female genitalia relatively short and broad. Both members of this group are from north-east Queensland.

Chimarra natalicia sp. nov.

Figures 26–28, 104, 105

Chimarra sp. nov. CT-221.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Birthday Ck, 3.5 km WNN Paluma, 18°59′S, 146°10′E, at light, 8 Oct 1989, R. St Clair (NMV, T-17688). Paratypes. 14 males, 16 females (specimen CT-309 figured), collected with holotype (NMV); 1 male (specimen CT-221 figured), same locality, 1 Apr 1990, R. St Clair (NMV); 2 males, same locality, 17 Mar 1990, R. St Clair (NMV).

Other material examined. Queensland. 1 male, 1 female, Windsor Tableland, 20 Feb 1982, MSM; 2 males, 5 females, Upper Freshwater Ck, Whitfield Range nr Cairns, 15 Dec 1974, Moulds; 1 male, Upper Freshwater Ck, Whitfield Range nr Cairns, MV-light, 24 Aug 1974, Moulds; 1 male, 1.5 km SE Kuranda, 16–17 May 1980, I.D. Naumann and J. Cardale (ANIC); 4 males, Bellenden Ker Range, Cableway Base Stn, 100 m, 1–7 Nov 1981, Earthwatch/Qld Museum; 1 male, 1 female, Bellenden Ker Range, Cableway Base Stn, 100 m, 17–24 Oct 1981, Earthwatch/Qld Museum; 1 male, Koolmoon Ck, Atherton Tablelands, site KM 1, 27 Nov 1990, S. Bunn and M. Gray; 1 male, Tully Falls, S of Ravenshoe, 11 Jan 1977, M.S. and B.J. Moulds; 2 males, 1 female, Birthday Ck, 3.5 km WNN Paluma, 18°59′S, 146°10′E, at light, 17 Feb 1990, R. St Clair; 1 female, Paluma, 27 Jan 1982, MSM; 1 female, Birthday Ck below falls, Mt Spec State

Forest, 18°57′S, 146°10′E, 760 m, lt. tr., 17 Mar 1994, A.L. Sheldon; 2 males, 4 females, same site, 29 Mar 1994; 7 females, Echo Ck tributary, Mt Spec State Forest, 18°57′S, 146°10′E, 735 m, lt. tr., 7 Nov 1993, A.L. Sheldon; 1 female, Echo Ck, Mt Spec State Forest, 18°57′S, 146°10′E, 735 m, lt. tr., 5 Mar 1994, A.L. Sheldon; 1 female, Echo Ck, Mt Spec State Forest, 18°57′S, 146°10′E, 700 m, lt. tr., 17 May 1994, A.L. Sheldon; 1 female, Running River, Mt Spec State Forest, 18°57′S, 146°10′E, 640 m, lt. tr., 16 Mar 1994, A.L. Sheldon.

Diagnosis. Males of this species resemble those of *C. neboissi* having the ventral process on segment IX relatively elongate, acute, projecting between bases of inferior appendages, but differ in that the apices of the inferior appendages are turned mesally and extended into a digitiform process, which is narrowly separated from the subapical angle, forming a deep notch.

Description. Head brown, body and wings light brown; length of forewing: male 4.8–5.4 mm, female 5.7–6.4 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX relatively elongate, acute, projecting between bases of inferior appendages (Figs 26, 27); inferior appendages in lateral view, very short, robust, length about 1.2 times width (Fig. 26), in ventral view stout, with apices turned mesally and extended into a digitiform process, which is narrowly separated from the subapical angle, forming a deep notch (Fig. 27); mesal processes of tergum X not apparent, lateral processes of tergum X robust, inflected apically; phallus robust with many small endothecal spines embedded subapically (Figs 26–28).

Female. Female genitalia relatively short, broad; sternum VII with a keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII with a large notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with 2 lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 104, 105).

Etymology. Natalicia – Latin word for birthday (type locality Birthday Creek).

Remarks. Chimarra natalicia is a common north eastern Queensland species (latitudinal range 16°10′–19°00′S).

Chimarra neboissi sp. nov.

Figures 29–31, 108, 109

Chimarra sp. nov. CT-223.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Little Mulgrave R., 9 km SW of Gordonvale, 17 Nov 1979, A.N. (NMV, T-17722). Paratypes. 7 males (specimen CT-223 figured), 5 females (specimen CT-324 figured), collected with holotype (NMV).

Other material examined. Queensland. Mt Webb National Park, Hopevale Mission, Cooktown area, Whitfield Range nr Cairns, Mareeba district, nr Gordonvale, NW of Tully, Kirrama State Forest, Mt Spec State Forest (ANIC, NMV).

Diagnosis. Males of *Chimarra neboissi* resemble those of *C. natalicia* having the ventral process on segment IX relatively elongate, acute, projecting between bases of inferior appendages, but differ in that the apices of the inferior appendages are separated widely from the basal angle, forming a wide notch. The wing venation in some specimens appears variable in that fork 1 in the hindwing is sometimes missing or not apparent.

Description. Head, body and wings dark brown to blackish; length of forewing: male 4.5–5.3 mm, female 5.1–5.9 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 1, 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX relatively elongate, acute, projecting between bases of inferior appendages (Figs 29, 30); inferior appendages in lateral view, short, tapering slightly apically, length about twice width (Fig. 29), in ventral view stout, with apices separated widely from basal angle, forming a wide notch (Fig. 30); mesal processes of tergum X not apparent, lateral processes of tergum X short, robust, situated below phallus; phallus robust with two long slender endothecal spines embedded subapically (Figs 29–31).

Female. Female genitalia relatively short, broad; sternum VII with a small keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites joined forming a central 'T-shaped' pigmented area. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without any lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 108, 109).

Etymology. Neboissi – named after Dr Arturs Neboiss (collector).

Remarks. Chimarra neboissi is a common dark species known from north-eastern Queensland (latitudinal range 15°04′–18°57′S). Superficially *C. neboissi* males can be confused with another very common north-eastern Queensland dark species, *C. karakara*, but the species can be distinguished by the length of the ventral process on segment IX.

Chimarra uranka-group

The *C. uranka*-group of two species, *C. uranka* and *C. ranuka*, is characterised primarily by male genitalia with phallus with large dorsal phallic projection or 'apicodorsal extension of the phallotheca'. Other common but not exclusive characters are brownish body and wings, wings unicolorous, forewing with vein Rs thickened basal to discoidal cell, in males tergum X with pair of mesal processes, phallus with one apical spine, inferior appendages in lateral view, broadbased and tapered apically, ventral process on segment IX small and keel-like. Both are from northern Australia.

Chimarra uranka Mosely

Figures 32–34, 94, 95

Chimarra uranka Mosely in Mosely and Kimmins, 1953: 399, fig. 273.—Neboiss, 1986: 106.

Type material. Holotype male, Queensland, Kuranda,1100 ft, 21 Jun–24 Jul 1913, R. E. Turner (BMNH). Type not seen.

Material examined. Queensland. 1 male (specimen CT-290 figured), 1 female (specimen CT-293 figured), trib. Bertie Ck, 250 m SW Heathlands H.S., 11 Feb 1992, Cartwright and Wells (QM); Cape York Peninsula, Cairns and Townsville areas, near Monto, Goomeri and Benarkin.

Northern Territory. Cape Crawford, Arnhemland, Kakadu, Litchfield and Katherine Gorge National Parks, Victoria River Downs.

Western Australia. Kimberley-Mitchell Plateau, Lake Argyle area, Bungle Bungle National Park, near Halls Creek, Giekie Gorge and Tunnel Ck.

Diagnosis. Chimarra uranka most closely resembles *C. ranuka* from which it is distinguished by the relatively short pair of mesal processes of tergum X and the dorsoventrally flattened apex of the dorsal phallic projection.

Description. Head orange-yellow, body and wings dark brownish; length of forewing: male 4.2–6.0 mm, female 4.4–7.0 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened slightly basal to discoidal cell.

Male. (Revised after Mosely in Mosely and Kimmins, 1953). Ventral process on segment IX small, keel-like; inferior appendages in lateral view, relatively robust, tapering slightly apically, length about twice width, upturned (Fig. 32), in ventral view, directed slightly distally (Fig. 33); pair of mesal processes of tergum X relatively short (Fig. 34), pair of lateral processes of tergum X short, robust (Figs 33, 34); phallus robust with single, short, upturned endotheeal spine visible apically, dorsally with single, slightly dorsoventrally flattened elongate dorsal phallic projection, with simple apex (Figs 32, 32a, 34).

Female. Female genitalia relatively short, broad; sternum VII with keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with 2 triangular lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cereus (Figs 94, 95).

Remarks. Chimarra uranka is an extremely common and widespread species throughout northern Australia (latitudinal range 10°48′–26°53′S). Mosely's, (in Mosely and Kimmins, 1953) figures have been redrawn to allow direct comparisons and to accompany the description that is revised in light of new interpretations of *Chimarra* genitalic structures.

Chimarra ranuka sp. nov.

Figures 35–37

Type material. Holotype male, Northern Territory, Litchfield National Park, UV light, 6 Jun 1991, Wells and Webber (NMV, T-17735). Paratypes. 2 males (specimen CT-291 figured), collected with holotype (NMV); 2 males, same locality, 3 Apr 1991, J. Webber and R. de Jong (NTM).

Diagnosis. This species most closely resembles *C. uranka* from which it is distinguished by the relatively long pair of mesal processes of tergum X and the concave apex of the dorsal phallic projection.

Description. Head, body and wings brownish; length of forewing: male 4.3–5.1 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In

forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, relatively slender, tapering slightly apically, length about 3.0 times width, upturned (Fig. 35), in ventral view, directed slightly distally (Fig. 36); pair of mesal processes of tergum X long, slender (Fig. 37), pair of lateral processes of tergum X robust, apices slightly turned outwards (Figs 35–37); phallus robust with single endothecal spine embedded apically, dorsally with single, slender, elongate phallic projection with concave apex (Figs 35, 35a, 37).

Female unknown.

Etymology. Ranuka – anagram of uranka.

Remarks. Chimarra ranuka appears to be restricted in distribution and probably is rare as it has been collected from the type locality only (latitude 13°28′S).

Chimarra tallawalla-group

The *Chimarra tallawalla*-group of two species, *C. tallawalla* and *C. wooroonoonan*, characterised primarily by male genitalia with phallus with long phallic (or endothecal) spines. Other non-exclusive characters are dark head, body and wings, wings unicolorous, forewing with vein Rs not thickened and straight basal to discoidal cell, in males tergum X with at most a small pair of mesal or lateral processes, inferior appendages in lateral view, slender and upturned, ventral process on segment IX small and keel-like. Both are from eastern Australia.

Chimarra tallawalla sp. nov.

Figures 38–40, 106, 107

Chimarra sp. nov. CT-224.—Cartwright, 1997: 17.

Type material. Holotype male, New South Wales, Cangi Ck, NW of Grafton, 29°34′S, 152°26′E, 15 Jan 1985, G. Theischinger (NMV, T-17738). Paratypes. 15 males (specimen CT-224 figured), 18 females (specimen CT-304 figured), collected with holotype (NMV).

Other material examined. Queensland. 1 male pupa, Nerang R., nr Advancetown, 8 Feb 1973, collector?; 1 male, Mt Superbus, 22 Jan 1971, S.R. Monteith (ANIC); 5 males, 2 females, Wallangarra, Qld-NSW border, 31 Dec 1956, J.K. New South Wales. 1 female, Korumbyn Ck, 28°24′S, 153°19′E, E slope of Mt Warning, 29 Jul 1988, AN; 2 females, Undercliffe Falls, 25 km E of Stanthorpe, 11 Oct, 1973, AN; 17 males, 20 females, Clarence R. at Yates Crossing, 26 Oct 1981, Wells and Carter; 34 males, 20 females, Cangi Ck, NW of Grafton, 29°34′S, 152°26′E, 15 Jan 1985, Theischinger; 17 males, 19 females, Boyd R., 5 km E of Dalmerton on old Grafton Rd, 27 Oct 1981, Wells and Carter; 1 male, Fernbrook nr Dorrigo, 17 Dec 1975, A.B. Prose?; 2 males, Bellinger R., 30°26′S, 152°44′E, 31 Oct 1981, Wells and Carter; 6 males, Styx R., 12 km S of Ebor, 17 Oct 1973, AN; 12 males, 18 females, Styx R. at Forest Camp in Styx River State Forest, 28 Oct 1981, Wells and Carter; 3 males, Apsley R. at falls, SE of Walcha, 29 Oct 1981, Wells and Carter; 8 males, 41 females, Wilson R., NW of Wauchope, 31°14′S, 152°34′E, 30 Oct 1981, Wells and Carter; 1 male, 8 females, Duffers Ck, 9 km WSW Barrington, 16 Feb 1980, A. Calder; 33 males, 55 females, Gloucester R., 9 km SW of Gloucester, 17 Feb 1980, A. Calder; 2 females, U. Allyn R., 12 km N of Eccleston, 21 Feb 1980, A. Calder; 2 males, 3 females, 'Tuglo' 48 km N of Singleton, 3 Feb 1979, Smithers; 2 males, 6 females, 'Tuglo' 48 km N of Singleton, alt. 780m, 5 Oct 1975, MSM; 34 males, 58 females, Allyn R., NE of Eccleston, 3 Nov 1981, Wells and Carter; 3 males, 32 females, Allyn R. nr Allynbrook, 21 Mar 1973, AN; 2 male pupae, Tuross R., 3 Feb 1977, J. Dean.

Diagnosis. Males of *Chimarra tallawalla* resemble those of *C. wooroonooran*, but differ in having the phallus with paired, very slender, very elongate phallic (or endothecal) spines dorsally, attached near base of phallotheca, often extending past apex of phallus.

Description. Head, body and wings brown; length of forewing: male 5.1–6.3 mm, female 5.4–7.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, short, slender, length about 4.0 times width, upturned slightly (Fig. 38), in ventral view, short, broadbased (Fig. 39); mesal processes of tergum X not apparent (Fig. 40), pair of lateral processes of tergum X short, robust, situated below phallus (Figs 38, 39); phallus relatively slender with pair of very slender, very elongate phallic (or endothecal) spines dorsally, attached near base of phallotheca (Figs 38–40, 38a), although sometimes withdrawn and so not as apparent (Figs 38b, 40a).

Female. Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with sclerites near middle and groups of setae ventrally. Ventrally posterior margin of segment VIII straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with 2 pockets laterally. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 106, 107).

Etymology. Tallawalla – NSW Aboriginal word for forest country (habitat).

Remarks. Chimarra tallawalla is a common but distinctive species found in eastern New South Wales and southeastern Queensland (latitudinal range 28°02′–36°06′S).

Chimarra wooroonooran sp. nov.

Figures 41–43, 110, 111

Chimarra sp. nov. CT-228.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male (specimen CT-228 figured), Queensland, Bellenden Ker Range, 0.5 km S Cable Tower No. 7, 500m, 25–31 Oct 1981, Earthwatch/Qld Museum (NMV, T-17904). Paratype. 1 female, collected with holotype (specimen CT-314 figured, NMV).

Diagnosis. This species differs from *C. tallawalla* in having the phallus with paired slender, long phallic (or endotheeal) spines laterally, attached near base of endotheca, never extending past apex of phallus.

Description. Head, body and wings brown; length of forewing: male 4.2 mm, female 5.0 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs not thickened but curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, slender, length about 3.0 times width, upturned, tapering slightly apically (Fig. 41), in ventral view, broadbased, apices turned slightly mesally (Fig. 42); pair of short mesal processes of tergum X pale, not obvious, lateral processes of tergum X not apparent; phallus robust, with pair of long and slender phallic (or endotheeal) spines embedded laterally, apices turned slightly outwards, and with about 5 small dark endotheeal spines embedded subapically (Figs 41–43, 41a).

Female. Genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with selerites and associated setae dorsally and near middle. Ventroposterior margin of segment VIII with a number of long setae, relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without any apparent pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cereus (Figs 110, 111).

Etymology. Wooroonooran – Queensland Aboriginal word for Bellenden Ker Range (type locality).

Remarks. Chimarra wooroonoonan is known from only one male and one female specimen from the type locality only in northeastern Queensland (latitude 17°16′S).

***Chimarra adaluma*-group**

The *C. adaluma*-group of five species, *C. adaluma, C. yoolumba, C. nabilla, C. akruna* and *C. pita*, is characterised primarily by males with tergum X and/or IX with one or two pairs of slender and elongate mesal processes, and phallus with a dorsal selerotised 'hood-like' projection. Other common but not exclusive characters are body and wings brownish, wings unicolorous, forewing, with vein Rs thickened and curved slightly basal to discoidal cell, inferior appendages in lateral view, broadbased and upturned apically, phallus with strong ventral endotheeal spine or ventral process, ventral process on segment IX small and keel-like. All members of this group are from northwestern Australia (N-WA and N-NT).

Chimarra adaluma sp. nov.

Figures 44–46

Chimarra sp. nov. CT-268.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, Kimberley, Prince Regent R., King Cascade, MV lt, 27 Jul 1990, D.K. Yeates (NMV, T-17773). Paratypes. 14 males (specimen CT-268 figured), collected with holotype (NMV).

Other material examined. Western Australia. 22 males, CALM site 28/3, 4 km W of King Cascade, 15°35′S, 128°15′E, 17–20 Jun 1988, T.A. Weir (ANIC).

Diagnosis. Chimarra adaluma is distinguished from others in the group by the 1 pair of curved spine-like mesal processes of tergum X and the lateral pair of processes of tergum X with apices almost meeting ventral to the phallus.

Description. Head pale, body and wings light brown; length of forewing: male 4.8–5.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, robust, subquadrate, length about 1.1 times width (Fig. 44), in ventral view, length about 2.5 times width, with apices directed slightly mesally (Fig. 45); pair of mesal processes of tergum X or IX slender, curved (Fig. 46), pair of lateral processes of tergum X project below phallus; phallus

relatively robust with single, slender, ventral endotheeal spine and dorsal sclerotised slightly flanged 'hood-like' projection (Figs 44–46).

Female unknown.

Etymology. Adaluma – Australian Aboriginal word for river (habitat).

Remarks. Chimarra adaluma has been found at only two sites in the Kimberley region of north Western Australia (latitudinal range 15°35′–15°38′S).

Chimarra yoolumba sp. nov.

Figures 47–49, 100, 101

Chimarra sp. nov. CT-264.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, Fortescue Falls, Hamersley Range National Park, 27 Oct 1979, J. B. (NMV, T-17788). Paratypes. 5 males (specimen CT-264 figured), 5 females (specimen CT-265 figured), collected with holotype (NMV).

Other material examined. Western Australia. 3 males, Hamersley National Park, Fortescue Falls, 23°38′S, 118°33′E, 23 Apr 1992, Cranston and Gullan (ANIC).

Diagnosis. This species most closely resembles *C. nabilla* in general form of male genitalic structures, but is distinguished by having the inner pair of mesal processes of tergum X relatively widely separated, situated adjacent to outer pair.

Description. Head pale brown, body and wings brownish; length of forewing: male 5.3–5.7 mm, female 6.6–7.1 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, robust, length about twice width, upturned slightly (Fig. 47), with apices turned slightly mesally and extended into a digitiform process (Fig. 49), in ventral view, length about twice width (Fig. 48); 2 pairs of dark mesal processes of tergum X, slender, straight, of similar length, individual process of each pair widely separated, but inner and outer processes adjacent (Fig. 49), lateral processes of tergum X not apparent; phallus relatively robust, with ring of about 6 dark, stout endotheeal spines subapically and dorsal sclerotised 'hood-like' projection (Figs 47, 48).

Female. Female genitalia relatively short, broad; sternum VII with keel-like process. Posterolateral margin of segment VIII with selerites and associated setae dorsally, near middle and ventrally. Ventral pair of selerites relatively narrowly separated, with connecting posterior margin of segment VIII straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without any lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 100, 101).

Etymology. Yoolumba – Western Australian Aboriginal word for the Fortescue River (type locality).

Remarks. This species is known from the type locality only in the Pilbara region, north Western Australia (latitude 23°38′S).

Chimarra nabilla sp. nov.

Figures 50–52, 102, 103

Chimarra sp. nov. CT-267.—Cartwright, 1997: 17.

Type material. Holotype male, Western Australia, Kimberley, Prince Regent River, King Cascade, MV light, 27 Jul 1990, D.K. Yeates (NMV, T-17799). Paratypes. Western Australia. 3 males (specimen CT-267 figured), collected with holotype (NMV); 1 male, Backsten Ck. S of Prince Regent Reserve, 16°00′S, 125°29′E, 6 Sep 1996, I. Edwards (NMV); 2 males, 2 females (specimen CT-325 figured), Mitchell Plateau, Lone Dingo Ck, trib. of Mitchell R., 17 Feb 1979, J.E.B. (NMV); 3 males, 'The crusher', CALM site 9/1, 4 km S by W mining camp, Mitchell Plateau, 14°52′S, 125°50′E, at light, 2–6 Jun 1988, I. D. Naumann (ANIC).

Other material examined. Northern Territory. 29 males, 42 females, Berry Springs, MV light, 26 Jun 1991, Wells and Webber (NTM); 4 males, Berry Springs, 12°42′S, 130°58′E, 7 May 1992, Wells (NTM). Western Australia. 3 males, nr Mitchell Plateau airfield, 14°48′S, 125°49′E, at light, 15 May 1983, J.C. Cardale (ANIC).

Diagnosis. Chimarra nabilla most closely resembles *C. yoolumba* in general form of male genitalic structures, but is distinguished by having two pairs of dark, relatively stout mesal processes of tergum X, inner pair of processes adjacent and slightly shorter than outer pair which are situated slightly ventrally with respect to inner pair.

Description. Head pale with brownish triangular area anterior to ocelli, body and wings brownish; length of forewing: male 4.0–5.2 mm, female 4.6–6.0 mm; wing venation: forewing with forks 1, 2, 3 and 5; hindwing with forks 2, 3 and 5. In forewing, discoidal cell with distal veins thickened and Rs thickened and slightly sinusoidal distal to discoidal cell.

Male. Ventral process on segment IX small,

keel-like; inferior appendages in lateral view, robust, length about 1.5 times width, upturned slightly (Fig. 50), with apices turned slightly mesally and extended into digitiform process (Fig. 52), in ventral view, length about 2.5 times width (Fig. 51); 2 pairs of dark mesal processes of tergum X, relatively stout, slightly curved, inner pair of processes adjacent and slightly shorter than outer pair (Fig. 52), which are situated slightly ventrally with respect to inner pair (Fig. 50), lateral processes of tergum X not apparent; phallus relatively robust with ring of about 5 dark, stout endotheeal spines subapically and 1 apically and with pale dorsal selerotised 'hood-like' projection (Figs 50–52).

Female. Female genitalia relatively short, broad; sternum VII with keel-like process. Posterolateral margin of segment VIII with selerites and associated setae dorsally, near middle and ventrally. Ventral pair of selerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum without any lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cereus (Figs 102, 103).

Etymology. Nabilla – Australian Aboriginal word for water.

Remarks. Chimarra nabilla is a slightly variable species with male specimens from the Northern Territory differing from the type material, mainly in the positioning and angle of the spines on the phallus. Known from the Kimberley region of northern Western Australia and Berry Springs, northern Northern Territory (latitudinal range 12°42′–16°00′S).

Chimarra akruna sp. nov.

Figures 53–55, 96, 97

Chimarra sp. B.— Wells, 1991: 20.
Chimarra sp. nov. CT-269.—Cartwright, 1997: 17.

Type material. Holotype male, Northern Territory, Radon Springs, lt tr., 14 Apr 1989, AW and PS (NMV, T-17808). Paratypes. 13 males (specimen CT-294 figured), 6 females (specimen CT-295 figured), collected with holotype (NMV).

Other material examined. Northern Territory. 1 male, E. Alligator R. at Cahills Crossing, lt tr., 27 May 1988, AW and PS; 5 males, 5 females (including 3 copulating pairs), ARRS Radon Springs, lt tr., 13–14 Apr 1988, AW and PS; 4 males, 1 female, same locality, lt tr., 14 Apr 1989, AW and PS; 4 males, 1 female, ARRS Radon Springs, lt tr., 12°45′S, 132°55′E, 13–14 Apr 1989, AW and PS; 2 males, ARRS Radon Springs, lt tr., 12°45′S, 132°55′E, 13–14 Apr 1989, AW and PS; 7 males, 4 females, ARRS Radon Springs, lt tr., 13–14 Apr 1988, AW and PS?; 2 males, ARRS Radon Springs, lt tr., 14 Apr 1989, AW and PS; 24 males, 27 females, ARRS Radon Springs, lt tr., 18–19 May 1988, AW and PS; 3 males, Randon (Radon?) Ck, Kakadu National Park 3 Sep 1979, JB; 2 males, 1 female, ARRS Bowerbird Billabong outlet, 12°47′S, 132°02′E, 1 Oct 1988, PD; 1 male, ARRS Baroalba Springs, 22 May 1988, AW and PS; many males, females, Baroalba Springs, Kakadu National Park, UV, 12°48′S, 132°49′E, 16 Jan 1992, Wells (NTM); many males, females, same locality, 4 Mar 1992, Wells (NTM); 1 male, 1 female, Jim Jim Ck, 3 km below falls, Kakadu National Park, 1 Sep 1979, JB; 1 male, 2 females, Graveside Gorge, lt trap, 18 Jul 1988; P.D.; 12 males, 8 females, ARRS Graveside Gorge, lt trap, 18 Jul 1988, PD; 3 males, 7 females, Graveside Ck, lt trap, 18 Jul 1988, PD; 4 males, 1 km below Twin Falls, Kakadu National Park, lt tr., 30 Aug 1979, JB; 12 males, 5 females, ARRS ck 5 km W of OSS, 13°33′S, 132°34′E, 19 Apr 1989, AW and PS; 2 males, 1 female, ARRS Stag Ck at BHP camp, lt tr., 25 May 1988, AW and PS; 1 male, ARRS S Alligator R.above Fisher Ck jn, lt tr., 19–20 Apr 1989, AW and PS; 3 males, Devil Devil Ck, 70 km SW Daly R. Mission, 23 Aug 1979, JB.

Diagnosis. Chimarra akruna closely resembles *C. pita* in general form of male genitalic structures, but is distinguished by having 2 pairs of dark, long and slender mesal processes of tergum X, all of similar length, individual processes of inner pair adjacent, outer processes slightly more widely separated.

Description. Head pale with brownish triangular area anterior to ocelli, body and wings brownish; length of forewing: male 4.5–5.5 mm, female 4.9–5.7 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, robust, length about twice width, upturned and tapering slightly apically (Fig. 53), in ventral view, length about 2.5 times width (Fig. 54); 2 pairs of dark mesal processes of tergum X, slender, slightly curved, of similar length (Fig. 55), individual processes of inner pair adjacent, outer processes slightly more widely separated (Fig. 55), robust pair of lateral processes of tergum X situated below phallus (Figs 53–55); phallus relatively robust with broadbased process ventrally (Fig. 54) and dorsal selerotised 'hood-like' projection (Figs 53, 54).

Female. Female genitalia relatively short, broad; sternum VII with keel-like process.

Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of poorly defined lightly pigmented subtriangular sclerites, their inner margins touching at base. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 96, 97).

Etymology. Akruna - anagram of uranka.

Remarks. Chimarra akruna is a common species throughout the Alligator Rivers region, northern Northern Territory (latitudinal range 12°26′–13°34′S).

Chimarra pita sp. nov.

Figures 56–58, 98, 99

Type material. Holotype male, Mitchell Plateau, Camp Ck, lt tr., 13 Jul 1978, PS and M. Tyler (NMV, T-17828). Paratypes. 1 male, Mitchell Plateau, Camp Ck at crusher, UV lt, 15 Feb 1979, JEB (NMV); 1 male, Mitchell Plateau, Camp Ck at crusher, UV lt, 15 Feb 1979, JEB (NMV); 1 male, Mitchell Plateau, Kimberley, lt tr., 30 Jan 1978, JEB (NMV); 1 male, Mitchell Plateau, Camp Ck, UV lt tr., 20 Jul 1978, PS and M. Tyler (NMV); 1 male (specimen CT-269 figured), Prince Regent R., Kimberley, 15°47′S, 125°24′E, May 1985, E. Bloomfield (NMV); 1 female (specimen CT-326 figured), Kimberley, Prince Regent R., 15°47′S, 125°24′E, May 1985, E. Bloomfield (NMV).

Other material examined. Western Australia. 1 male, nr Mitchell Plateau airfield, 14°48′S, 125°49′E, at light, 15 May 1983, J.C. Cardale (ANIC); 1 male, 'Marun' CALM site 8/4, Prince Frederick Harbour, 15°00′S, 125°21′E, at light, 6–11 Jun 1988, I.D. Naumann (ANIC); 5 males, CALM site 28/3, 4 km W of King Cascade, 15°35′S, 128°15′E, 17–20 Jun 1988, T.A. Weir (ANIC). Northern Territory. 117 males, 1 female, Litchfield National Park, UV light, 6 Jun 1991, Wells and Webber (NTM); 4 males, 2 females, Litchfield Park, MV light, 3 Apr 1991, J. Webber and R. De Jong (NTM); 1 male, 1 female, Litchfield National Park, lagoon nr Tolmer Falls, UV lt, 24–25 Jun 1992, Wells and Webber (NTM); 4 males, 5 females, Litchfield National Park, billabong, UV, 18–19 Apr 1992, AW (NTM); 1 male, Litchfield National Park, Walker Ck, 18 Apr 1992, AW (NTM).

Diagnosis. Chimarra pita most closely resembles *C. akruna* in general form of male genitalic structures, but is distinguished by having two pairs of dark slender, mesal processes of tergum X, outer pair about half to two-thirds length of inner pair, individual processes of inner pair adjacent, outer processes narrowly separated from inner processes.

Description. Head pale with brownish triangular area anterior to ocelli, body and wings brownish; length of forewing: male 4.0–4.8 mm, female 4.9–5.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, robust, length about twice width, upturned and tapering slightly apically (Fig. 56), in ventral view, length about 2.5 times width (Fig. 57); two pairs of dark mesal processes of tergum X, slender, slightly curved, outer pair about half to two-thirds length of inner pair, individual processes of inner pair adjacent, outer processes narrowly separated from inner processes (Fig. 58), pair of lateral processes of tergum X situated below phallus, relatively slender with slightly out turned apices (Figs 56–58); phallus relatively robust with broadbased process ventrally (Fig. 57) and dorsal sclerotised 'hood-like' projection (Figs 56, 58).

Female. Female genitalia relatively short, broad; sternum VII with short keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII slightly convex and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with poorly defined lightly pigmented areas. Tergum X forming 2 lobes with numerous setae, each with a relatively short apical cercus (Figs 98, 99).

Etymology. Pita – Australian Aboriginal word for four-pronged spear (four mesal processes on tergum X).

Remarks. Chimarra pita is found in the Kimberley region, north Western Australia, Litchfield Park, northern Northern Territory (latitudinal range 12°58′–15°47′S).

Chimarra monticola-group

The *C. monticola*-group of three species, *C. monticola*, *C. anstralica* and *C. kewarra*, is characterised by not possessing any of the primary distinguishing characters of the previous groups, but with male genitalia with relatively slender upturned inferior appendages. Other common but not exclusive characters are dark head, body and

wings, wings unicolorous, phallus with several endotheeal spines, ventral process on segment IX small and keel-like; females with pair of dark sub-triangular sclerites on ninth sternum. All members of this group are from eastern Australia.

Chimarra monticola Kimmins

Figures 59–61, 122, 123

Chimarra monticola Kimmins in Mosely and Kimmins, 1953: 402, fig. 275.—Neboiss, 1986: 105.—Cartwright, 1990: 19, fig. 16 (female).

Type material. Holotype male, New South Wales, Rules, Point, 4450 ft, 30 Dec 1934, R. J. Tillyard (BMNH). Type not seen.

Material examined. Tasmania. 1 male (PT-802), Great Lake, stream S of Breona, 27 Jan 1960, F. McDonald. Victoria. 1 male, (specimen CT-278 figured) OShannassy R., 12 Dec 1975, J. Dean and D. Cartwright; 1 female (specimen CT-322 figured), O'Shannassy R.–Yarra R. jn, 1 Dec 1977, J. Dean and D. Cartwright; Otway Ranges, Yarra River system, Mitta Mitta River system, north-east, East Gippsland, New South Wales. South-east, north-east. List of localities available from author.

Diagnosis. Resembling *C. australica* and *C. kewarra* in general form of male genitalia, but the form of the lateral processes on tergum X, with a pair of short, broadbased ventrolateral processes, is quite distinct from the hooked processes in those species.

Description. Head, body and wings black; length of forewing: male 6.0–7.3 mm, female 7.3–8.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs not thickened or curved basal to discoidal cell.

Male. (Revised after Kimmins in Mosely and Kimmins, 1953). Ventral process on segment IX small, keel-like; inferior appendages in lateral view, length about 3.0 times width, upturned, tapering slightly apically (Fig. 59), in ventral view, broadbased, apices turned slightly mesally (Fig. 60); no mesal processes of tergum X apparent, pair of lateral processes of tergum X short, broadbased; phallus relatively long, slender, with about 4 endotheeal spines embedded subapically (Figs 59–61).

Female. (Revised after Cartwright, 1990). Female genitalia relatively short, broad; sternum VII with weak keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with a membranous area almost dividing segment. Ninth sternum with pair of darkly pigmented triangular sclerites, length less than width, their inner margins touching at base. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 122, 123).

Remarks. Chimarra monticola is a common and widespread species throughout eastern NSW and Victoria, including one male specimen from central Tasmania (latitudinal range 21°02′–41°47′S). According to Neboiss (pers. comm.) the Tasmanian male (PT-802) is a close but distinct species. Kimmins' (in Mosely and Kimmins, 1953) and Cartwright's, (1990) figures have been redrawn to allow direct comparisons and to accompany the description that is revised in light of new interpretations of *Chimarra* genitalic structures.

Chimarra australica Ulmer

Figures 62–64, 118, 119

Chimarra australica Ulmer, 1916: 3–5, figs 3–6.—Mosely and Kimmins, 1953: 399, fig. 274.—Neboiss, 1986: 105.—Cartwright, 1990: 20, fig. 18 (female).

Type material. Holotype male, Queensland, Malanda, date and collector unknown (NRS). Type not seen.

Material examined. Queensland. 1 female, Zarda Ck nr Mt Misery, W of Mossman, 1200m, 23 Dec 1974, MSM; 1 male (CT-275), 25 km along Mt Lewis Rd, SW of Mossman, 16 Jan 1977, M.S. and B.J. Moulds; 1 male, Rocky Ck, 11 km N of Atherton, 3 May 1967, D.H. Colless (ANIC); 1 male (CT-276), Bellenden Ker Range, Cableway Base Station, 100m, 17–24 Oct 1981, Earthwatch/Qld Museum; 1 male (specimen CT-309 partly figured), Mt Spec State Forest, Birthday Ck above weir, 18°57′S, 146°10′E, lt tr., 13 Nov 1993, A.L. Sheldon; 2 males, 1 female, same site, 6 Dec 1993, A.L. Sheldon; 1 male, 1 female?, same site, 15 Oct 1993, A.L. Sheldon; 1 male, same locality, 6 Nov 1993; 1 male (specimen CT-292 partly figured), Finch Hatton Gorge, 21°07′S, 148°38′E, 14 Nov 1982, Theischinger; 1 female, (specimen CT-323 figured); 1 male, Mt Nebo area, slow stream at roadside, 1 May 1975, coll.? (ANIC); New South Wales. North-east, central east and south-east; 1 male (specimen CT-277 partly figured), Brogo River, 22 Jan 1977, J. Dean?. Victoria. East Gippsland, north-east, Yarra River system, Lal Lal Falls, near Lorne. List of other localities available from author.

Diagnosis. This species most closely resembles *C. kewarra* in general form of male genitalic structures, but is distinguished by having lateral processes of tergum X, with relatively short,

upturned or out turned apices. The phallus has a distinctive ventral process.

Description. Head, body and wings black to brownish-black; length of forewing: male 4.7–5.9 mm, female 4.9–7.0 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs not thickened or curved basal to discoidal cell.

Male. (Revised after Ulmer, 1916 and Mosely and Kimmins, 1953). Ventral process on segment IX small, keel-like; inferior appendages in lateral view, length about twice width, upturned, tapering slightly apically (Fig. 62), in ventral view, broadbased, apices turned slightly mesally (Fig. 63); mesal processes of tergum X not apparent, pair of lateral processes of tergum X broadbased, relatively slender apically, apices hooked upwards or sometimes outwards (Figs 62, 62a–c, 64, 64a–c); phallus relatively long, with ventral subapical process and 1 or 2 endothecal spines embedded subapically (Figs 62–64).

Female. (Revised after Cartwright, 1990). Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with a membranous area almost dividing segment. Ninth sternum with pair of darkly pigmented subtrapezoidal sclerites, their inner margins almost touching at base. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 118, 119).

Remarks. Chimarra australica is a very common, widespread and slightly variable species throughout eastern Australia (latitudinal range 16°34′–38°35′S).Ulmer's, (1916) and Cartwright's, (1990) figures have been redrawn to allow direct comparisons and to accompany the description that is revised in light of new interpretations of *Chimarra* genitalic structures.

Chimarra kewarra sp. nov.

Figures 65–67, 120, 121

Type material. Holotype male (specimen CT-287 figured), Queensland, Searys Ck, Rainbow Beach, 25°58′S, 153°04′E, 7 Jan 1986, G. Theischinger (NMV, T-17906). Paratypes. 2 females (specimen CT-310 figured), collected with holotype (NMV).

Diagnosis. Chimarra kewarra most closely resembles *C. australica* in general form of male genitalic structures, but is distinguished by having lateral processes of tergum X, with relatively long, upturned or out turned apices and phallus without a ventral process.

Description. Head, body and wings dark greyish-brown to black; length of forewing: male 4.7 mm, female 5.5–5.6 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, length about 2.5 times width, upturned, tapering slightly apically (Fig. 65), in ventral view, broadbased, apiees turned slightly mesally (Fig. 66); mesal processes of tergum X not apparent, pair of lateral processes of tergum X broadbased, laterally flattened (Figs 65, 66), in ventral view relatively slender apically (Fig. 66), apices hooked upwards; phallus robust, with pair of endothecal spines embedded subapically (Figs 65–67).

Female. Female genitalia relatively short, broad; sternum VII with small keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of lightly pigmented triangular sclerites, length greater than width, their inner margins almost touching at base. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 120, 121).

Etymology. Kewarra – Southern Queensland Aboriginal word for rainbow (type locality – Rainbow Beach).

Remarks. At present *Chimarra kewarra* is known only from the type locality in southeastern Queensland (latitude 25°58′S).

***Chimarra mouldsi*-group**

The *Chimarra mouldsi*-group, complex of four species, *C. mouldsi, C. stelairae, C. bibaringa* and *C. karakara*, is almost certainly not a natural group, but is characterised by not possessing any of the primary distinguishing characters of the previous groups, but all males have relatively short inferior appendages. Other common but not exclusive characters are dark head, body and

wings, wings unicolorous, tergum X without apparent mesal processes and with short lateral processes or lobes, ventral process on segment IX small and keel-like. All members are from north-east Queensland.

Chimarra mouldsi sp. nov.

Figures 68–70, 114, 115

Chimarra sp. nov. CT-225.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Upper Freshwater Ck, Whitfield Range nr Cairns, 15 Dec 1974, Moulds (NMV, T-17835). Paratypes. 4 males (specimen CT-225 figured), 1 female, collected with holotype (NMV); 1 male, same locality, 24 Aug 1974, MSM (NMV); 2 females (specimen CT-329 figured), Bellenden Ker Range, Cableway Base Stn, 100 m, 25–31 Oct 1981, Earthwatch/Qld Museum (NMV).

Other material examined. Queensland. 1 male, Black Mt Rd, E of Mt Molloy, 5 Dec 1974, MSM; 1 male, 1.5 km SE Kuranda, 16–17 May 1980, I.D. Naumann and J. Cardale (ANIC); 1 female, Cairns, Lake Morris Rd, MV lt, 16°55′S, 145°46′E, 16 Nov 1988, K. Walker; 1 female, Currunda Ck, Freshwater Ck trib., on road to Crystal Cascades, nr Cairns, 30 Apr 1979, AW; 2 males, Qld, Lock-Davies Ck Rd, Lamb Range, Mareeba district, 10 Nov 1974, MSM; 1 female, 25 km Gordonvale, Gillies H-way, 4 Sep 1974, MSM; 1 female, Bellenden Ker Range, Cableway Base Stn, 100 m, 1–7 Nov 1981, Earthwatch/Qld Museum; 4 females, Carron Ck, Kirrama State Forest, 17°50′S, 145°35′E, Apr 1993, G. Theischinger; 2 females, Goodard Ck, Kirrama State Forest, 18°06′S, 145°41′E, Apr 1993, G. Theischinger; 1 male (PT-1642), Yuccabine Ck, Kirrama State Forest, 18°12′S, 145°45′E, 2 Jan 1985, R. Pearson.

Diagnosis. Grouped with *C. stclairae, C. bibaringa* and *C. karakara* but distinguished by having inferior appendages which in lateral view are subquadrate, truncate apically.

Description. Brown head, body and wings; length of forewing: male 4.6–5.2 mm, female 4.6–5.2 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, short, robust, subquadrate, truncated, length about 1.5 times width (Fig. 68), in ventral view, length about same as width (Fig. 69); mesal processes of tergum X not apparent, pair of lateral processes of tergum X situated beside phallus, robust, tapering slightly apically (Figs 68, 70); phallus relatively robust with pair of dark, slender endothecal spines embedded subapically (Figs 68–70).

Female. Female genitalia relatively short, broad; sternum VII with short keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of irregular-shaped pigmented areas. Tergum IX with pigmented sclerotised area extending down sides and with truncate apices. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 114, 115).

Etymology. Mouldsi – named after Max Moulds (collector).

Remarks. Chimarra mouldsii is an uncommon and distinctive north-eastern Queensland species. (latitudinal range 16°41′–18°12′S).

Chimarra stclairae sp. nov.

Figures 71–73, 112, 113

Chimarra sp. nov. CT-226.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Birthday Ck, 3.5 km WNN Paluma, 18°59′S, 146°10′E, at light, 17 Feb 1990, R. St Clair (NMV, T-17875). Paratypes. 2 males, same locality and collector as holotype, 8 Oct 1989 (NMV); 7 males, 2 females, same locality and collector as holotype, 19 Jan 1990 (NMV);1 female (specimen CT-305 figured), same locality and collector as holotype, 17 Feb 1990 (NMV); 1 male (specimen CT-226 figured), same locality and collector as holotype, 1 Apr 1990 (NMV); 2 males, 1 female, Birthday Ck, 3.5 km WNN Paluma, 18°59′S, 146°10′E, at light, 23 Dec 1989, R. St Clair (NMV); 7 males, Birthday Ck, 3.5 km WNN Paluma, 18°59′S, 146°10′E, at light, 17 Mar 1990, R. St Clair (NMV); 1 male, 3 females, Birthday Ck below falls, Mt Spec State Forest, 18°57′S, 146°10′E, 760 m, lt. tr., 29 Mar 1994, A.L. Sheldon (NMV); 1 male, Birthday Ck, iron cabin, Mt Spec State Forest, 18°57′S, 146°10′E, 790 m, lt. tr., 23 Apr 1994, A.L. Sheldon (NMV).

Other material examined. Queensland. 1 male, 7 km N of Hopevale Mission, 15°14′S, 145°07′E, 4 Oct 1980, J.C. Cardale (ANIC); 1 male, 1 female, 8–13 km Mt Lewis Rd, off Mossman-Molloy Rd, 22 Apr 1967, D.H. Colless (ANIC); 1 male, 1 female, Kirrama State Forest, Western Fall, 30 May 1971, E.F. Riek (ANIC); 1 male, Birthday Ck, iron cabin, Mt Spec State Forest, 18°57′S, 146°10′E, 790 m, lt. tr., 23 Apr 1994, A.L. Sheldon; 1 male, 3 females, Birthday Ck below falls, Mt Spec State Forest, 18°57′S, 146°10′E, 760 m, lt. tr., 29 Mar 1994, A.L. Sheldon.

Diagnosis. Chimarra stclairae is grouped with *C. mouldsi, C. bibaringa* and *C. karakara* but can be distinguished by having inferior appendages which in lateral view are short, upturned, tapering slightly apically, in ventral view with small process on inner margin.

Description. Head, body and wings brown; length of forewing: male 4.6–5.5 mm, female 5.3–5.5 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, short, length about twice width, upturned, tapering slightly apically (Fig. 71), in ventral view, short, length about twice width, with small process on inner margin (Fig. 72); mesal and lateral processes of tergum X not apparent; phallus relatively short, with pair of long embedded endothecal spines (Figs 71–73).

Female. Female genitalia relatively short, broad; sternum VII with short keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae near middle and ventrally. Ventroposterior margin of segment VIII relatively straight and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of squarish depressions. Tergum IX with pigmented sclerotised area extending down sides and with relatively pointed apices. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cercus (Figs 112, 113).

Etymology. Stclairae – named after Ros St Clair (collector).

Remarks. This species is known from only northeastern Queensland (latitudinal range 15°14′–18°59′S).

Chimarra bibaringa sp. nov.

Figures 74–76

Chimarra sp. nov. CT-227.—Walker et al., 1995: 26.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Bellenden Ker Range, Cableway Base Stn, 100 m, 17–24 Oct 1981, Earthwatch/Qld Museum (NMV, T-17844). Paratypes. 1 male (specimen CT-227 figured), collected with holotype (NMV); 1 male, same locality and collector, 1–7 Nov 1981 (NMV).

Other material examined. Queensland. 1 male, Moses Ck, 4 km N by E Mt Finnigan, 14–16 Oct 1980, J.C. Cardale (ANIC); 1 male, Mossman Gorge, 16 Nov 1979, AN; 2 males, Upper Freshwater Ck, Whitfield Range nr Cairns, 15 Dec 1974, Moulds; 1 male, Upper Freshwater Ck, Whitfield Range nr Cairns, 24 Aug 1974, MSM; 1 male pupa, Little Mulgrave R., 28 Jun 1971, E.F. Riek (ANIC); 1 male, Base cableway, Mt Bellenden Ker, 80 m, 17°16′S, 145°54′E, 19 Oct 1981, E. D. Edwards (ANIC); 1 male, Williams Ck tributary, Mt Spec State Forest, 18°57′S, 146°10′E, 745 m, lt. tr., 13 Nov 1993, A.L. Sheldon; 4 males, Little Crystal Ck, Mt Spec, 29 May 1971, E.F. Riek (ANIC).

Diagnosis. This species is grouped with *C. mouldsi, C. stclairae* and *C. karakara* but can be distinguished by having lateral processes of tergum X with obvious elongate processes ventral to phallus.

Description. Head, body and wings dark brown to blackish; length of forewing: male 4.5–5.2 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like; inferior appendages in lateral view, short, subovate, length about 2.5 times width (Fig. 74), in ventral view, length about twice width, broadbased, tapering and curved apically (Fig. 75); mesal processes of tergum X not apparent, lateral processes of tergum X with elongate ventral processes, extending near apices of inferior appendages; phallus relatively robust with no embedded endothecal spines apparent (Figs 74–76).

Female unknown.

Etymology. Bibaringa – Queensland Aboriginal word for mountain.

Remarks. Chimarra bibaringa is a distinctive and uncommon north-eastern species (latitudinal range 15°48′–19°00′S).

Chimarra karakara sp. nov.

Figures 77–79, 116, 117

Chimarra sp. n. F.—Wells and Cartwright, 1993: 227.

Chimarra sp. nov. CT-222.—Cartwright, 1997: 17.

Type material. Holotype male, Queensland, Gunshot Ck, Telegraph Crossing, UV lt, 11°44′S, 142°29′E, 14–15 Feb 1992, Cartwright and Wells (NMV, T-17847). Paratypes. 1 male, collected with holotype (NMV); 1 male (specimen CT-273 figured) same locality and collectors, 18 Feb 1992; 2 males, 2 females (specimen CT-300 figured) same locality and collectors, 18 Feb 1992; 10 males, 11 females, same locality and collectors, 17 Feb 1992 (NMV).

Other material examined. Queensland. Iron Range, Mellwraith Range, near Cooktown, near Cairns, Bellenden Ker Range, Kirrama State Forest, Mt Spec State Forest, Eungella National Park (ANIC, NMV, QM). List of localities available from author.

Diagnosis. Chimarra karakara is grouped with *C. mouldsi, C. stclairae* and *C. bibaringa* but can be distinguished by having relatively long phallus with bulbous head with 3 obvious and characteristic small dark endothecal spines.

Description. Head, body and wings dark brown to blackish; length of forewing: male 4.4–5.8 mm, female 5.1–6.7 mm; wing venation: forewing with forks 1, 2, 3 and 5 present; hindwing with forks 2, 3 and 5 present. In forewing, vein Rs thickened and curved slightly basal to discoidal cell.

Male. Ventral process on segment IX small, keel-like: inferior appendages in lateral view, short, subovate, length about 1.5 times width (Fig. 77), in ventral view, length about 2.5 times width, curved slightly apically (Fig. 78); no mesal processes of tergum X apparent, pair of lateral processes of tergum X short; phallus relatively long, in lateral view with bulbous head with 3 obvious and characteristic embedded small dark endotheeal spines (Figs 77–79).

Female. Female genitalia relatively short, broad; sternum VII with short keel-like process. Posterolateral margin of segment VIII with sclerites and associated setae dorsally, near middle and ventrally. Ventral pair of sclerites relatively narrowly separated, with connecting posterior margin of segment VIII slightly convex and without notch. Segment VIII dorsally with membranous area almost dividing segment. Ninth sternum with pair of oblong pigmented areas. Tergum IX with pigmented sclerotised area extending down sides and with pointed apices. Tergum X forming 2 lobes with numerous setae, each with relatively short apical cereus (Figs 116, 117).

Etymology. Karakara – Queensland Aboriginal word for black (body and wings colour).

Remarks. Chimarra karakara is a very common and distinctive dark species found throughout northeastern Queensland (latitudinal range 11°44′–21°28′S).

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Index and checklist of species of *Chimarra* from Australia

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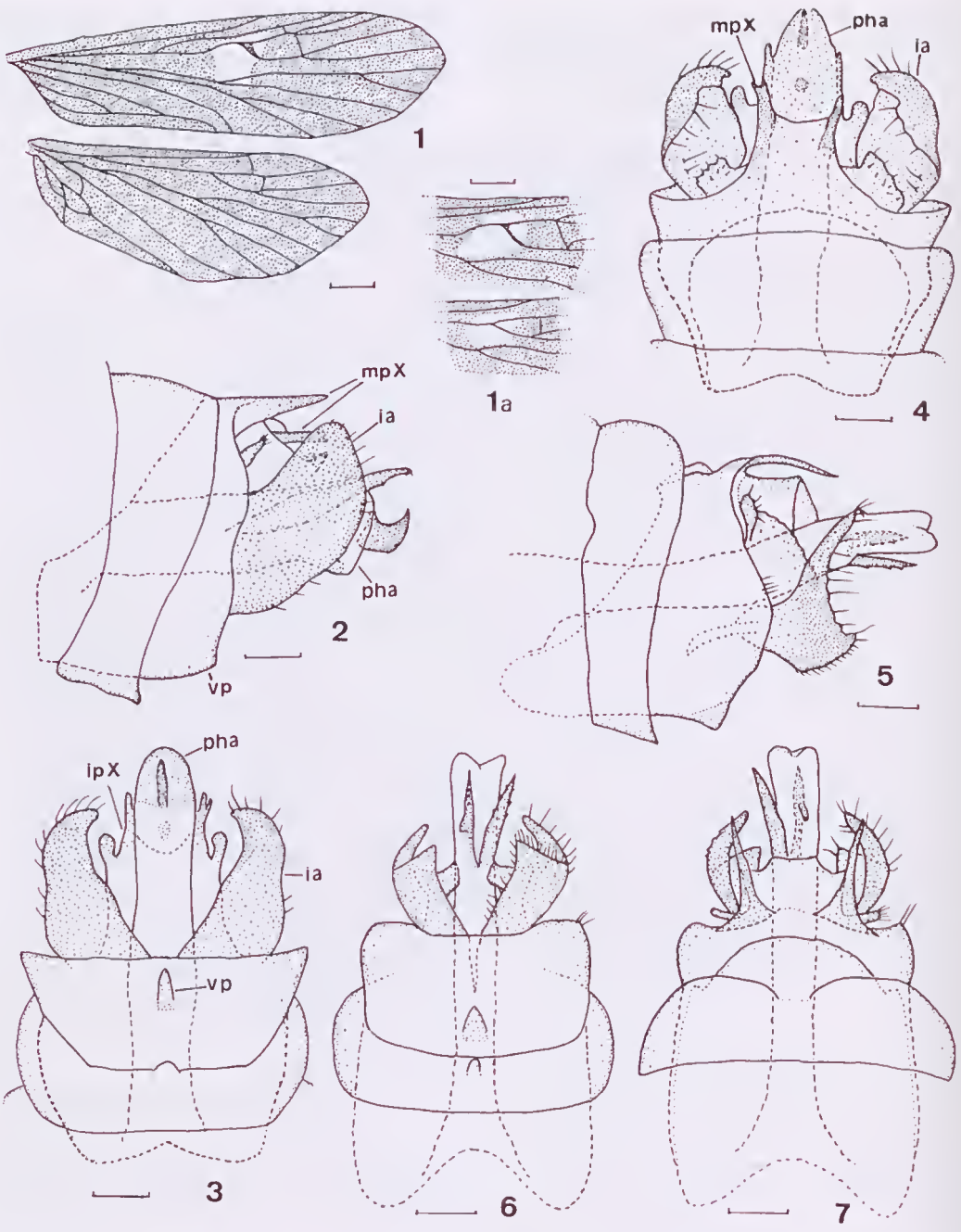
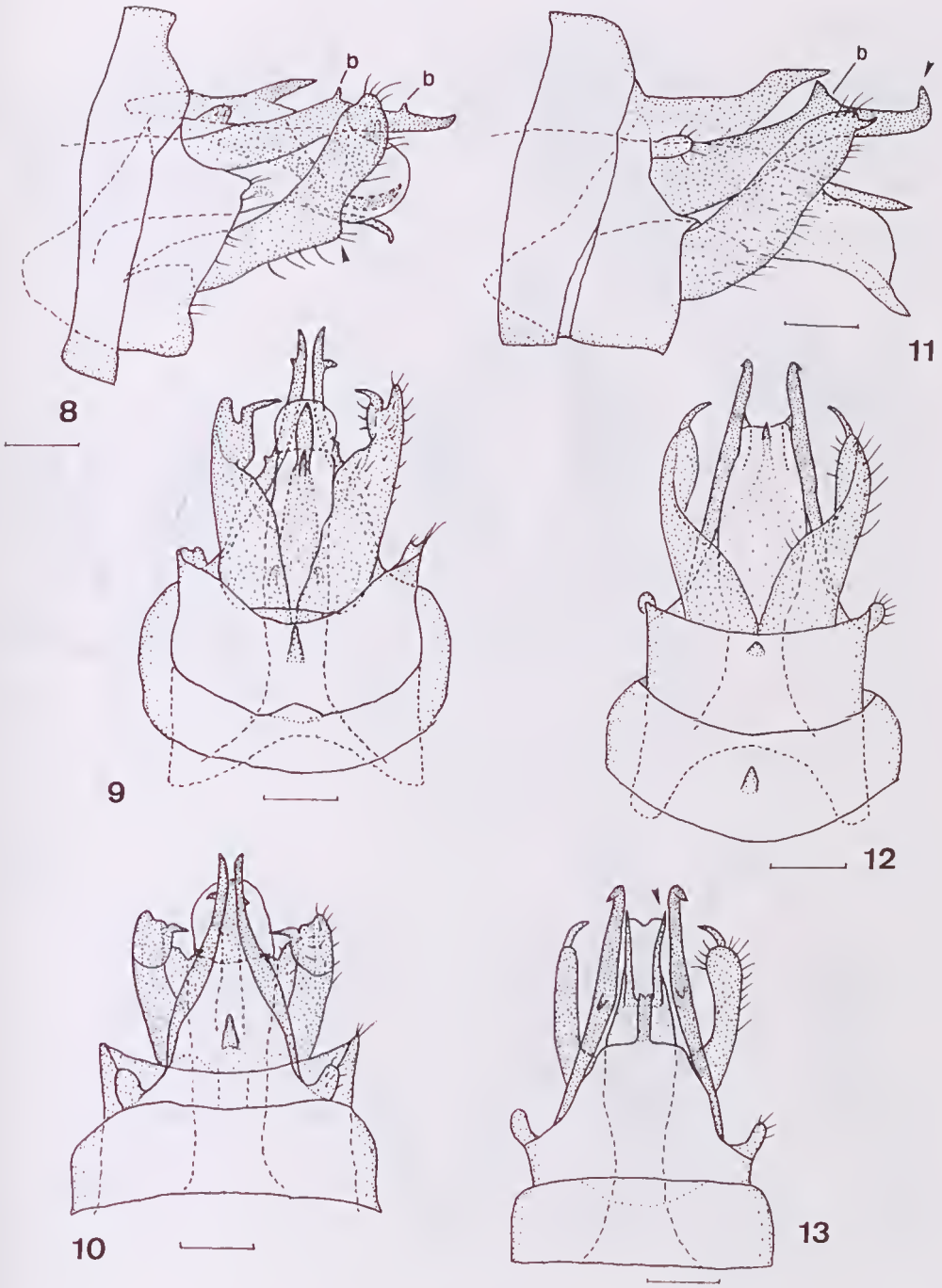


Figures 1–7. *Chimarra* spp. 1–1a: Wings. 1: *Chimarra luminaris* sp. nov. forewing and hindwing.1a: *Chimarra locolo* sp. nov. section of forewing and hindwing. 2–7: Male genitalia in lateral, ventral and dorsal views. 2–4: *Chimarra luminaris* sp. nov. 5–7: *Chimarra locolo* sp. nov.

Abbreviations: ia, inferior appendages; lp X, lateral process of abdominal tergum X; mp X, mesal process of abdominal tergum X; pha, phallus; vp, ventral process of abdominal segment IX. Scale lines: 1–1a, 0.5 mm; 2–7, 0.1 mm.



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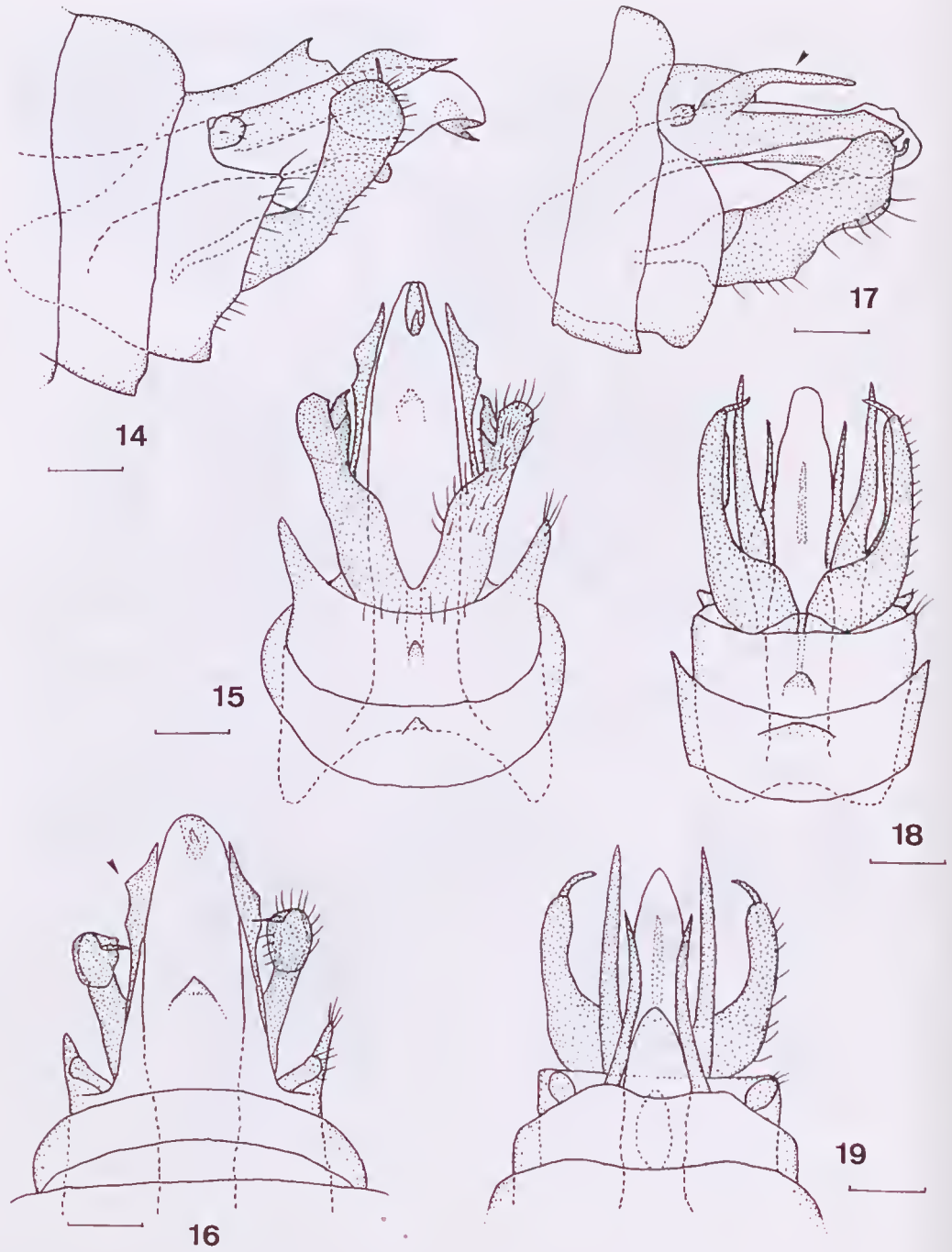

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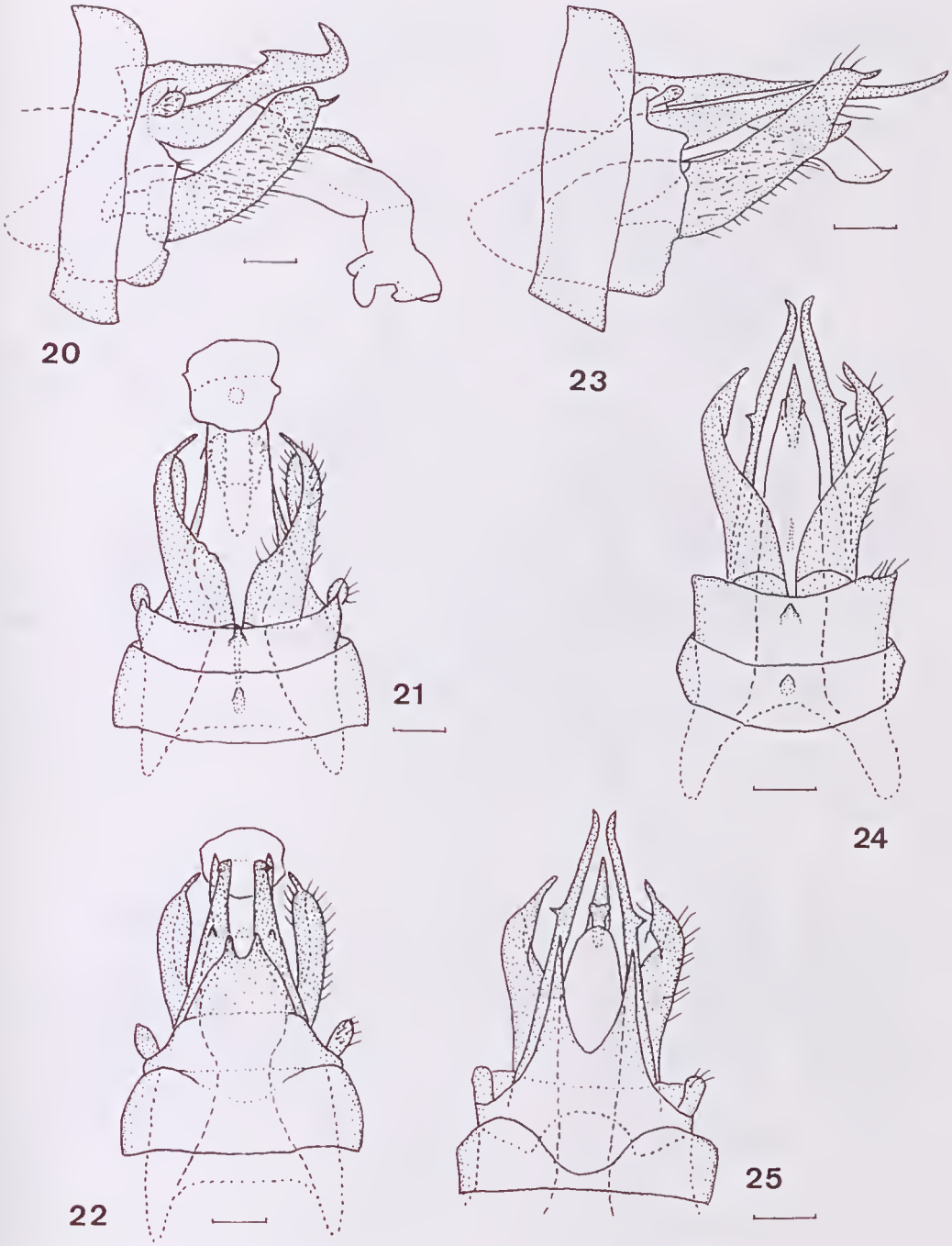

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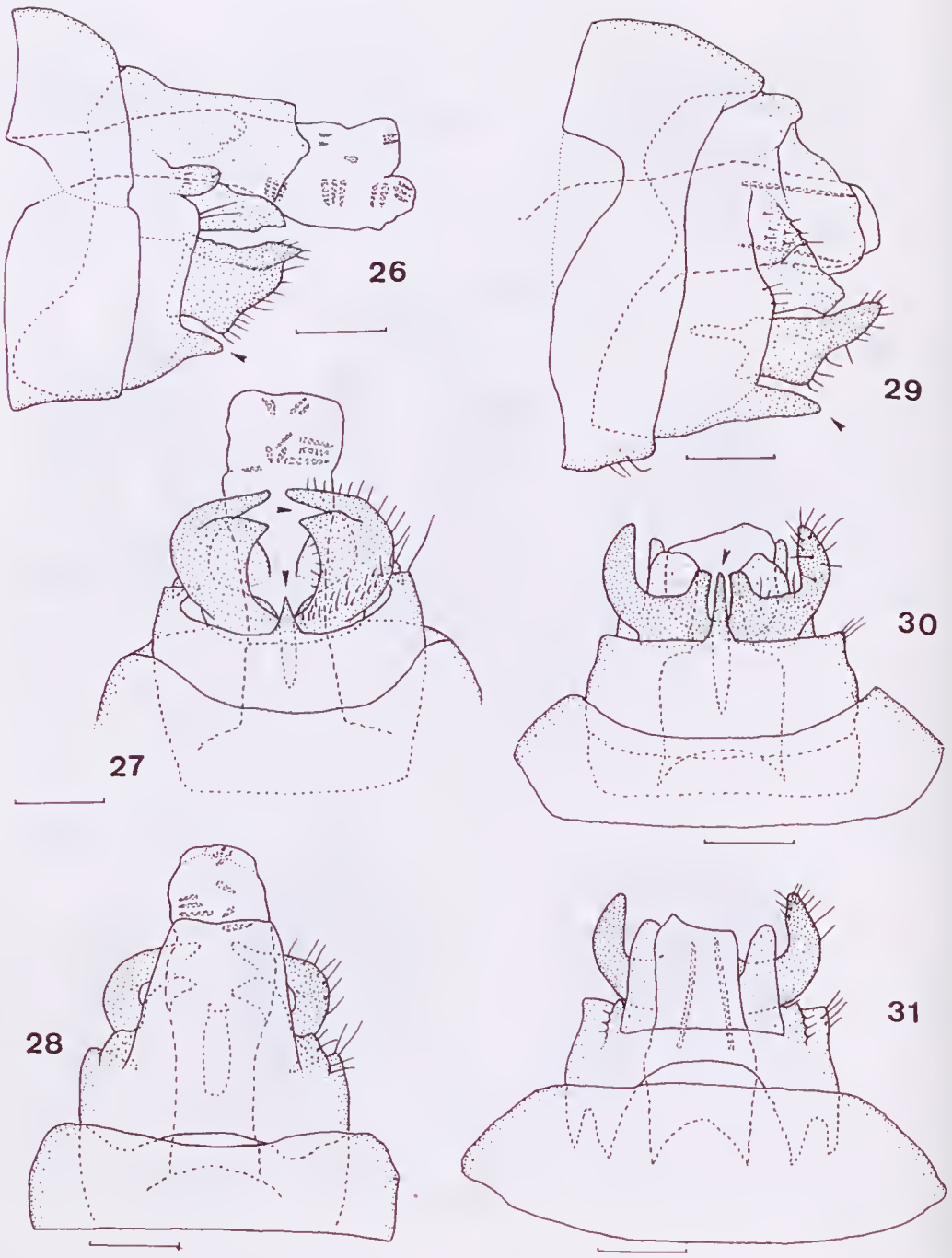

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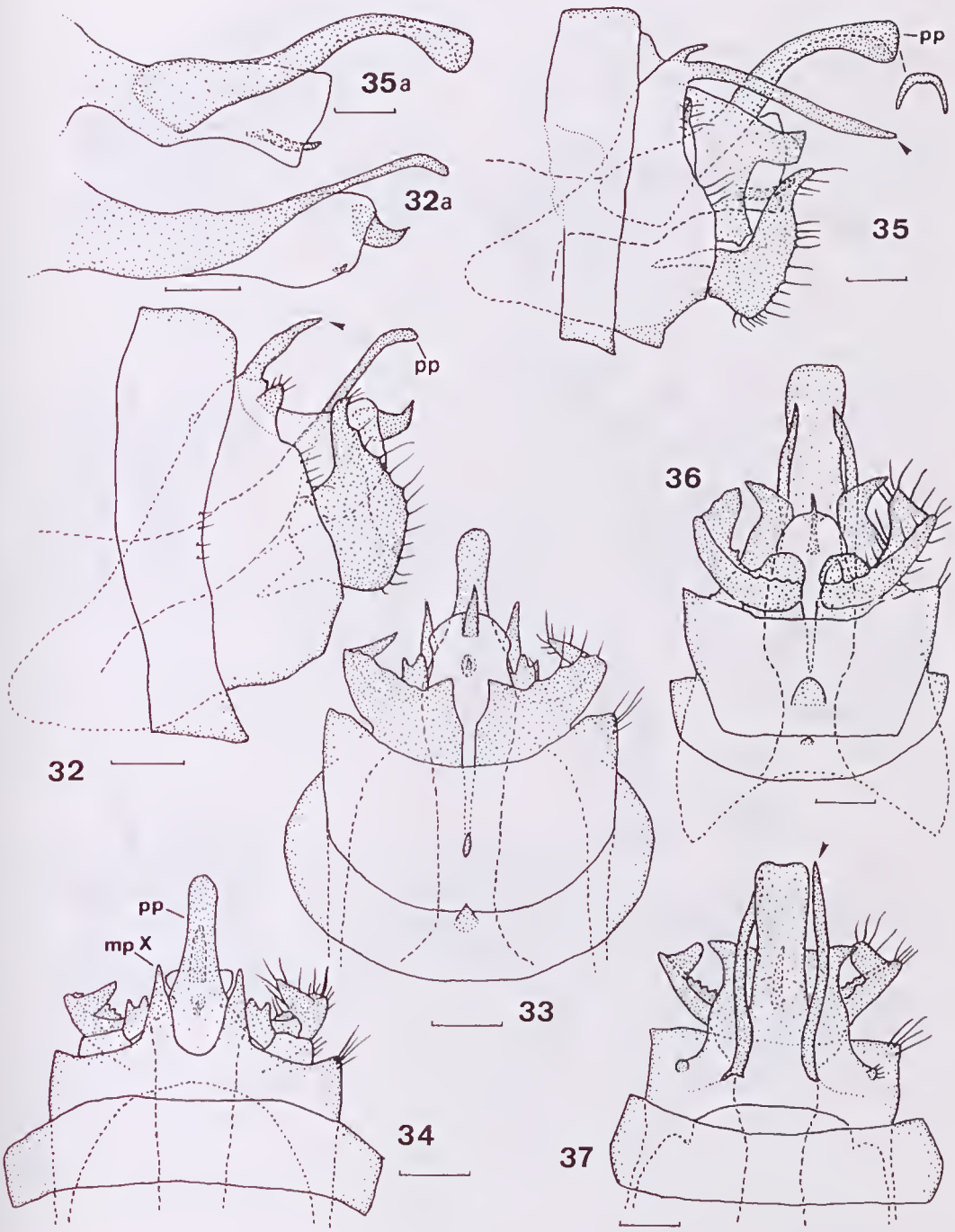

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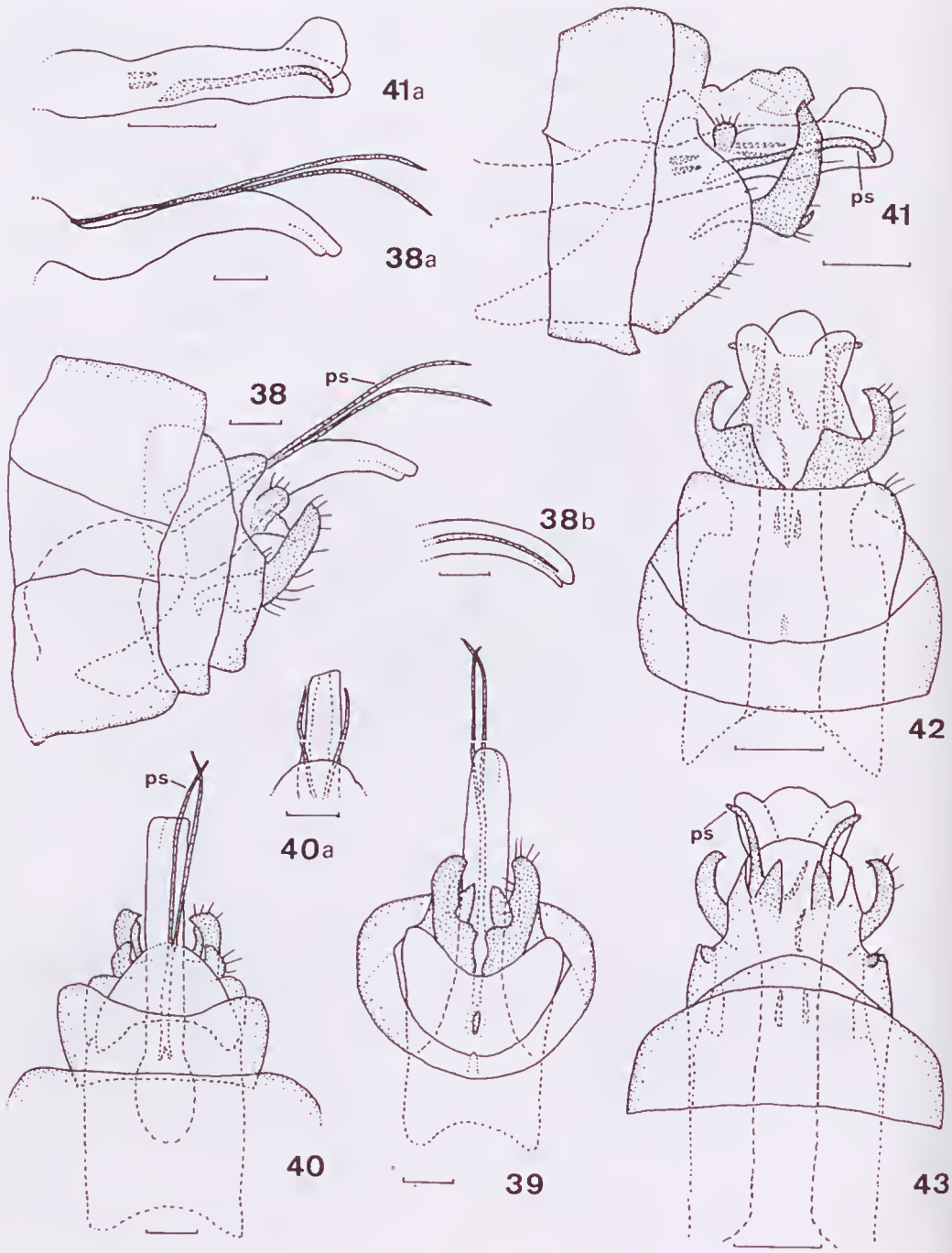

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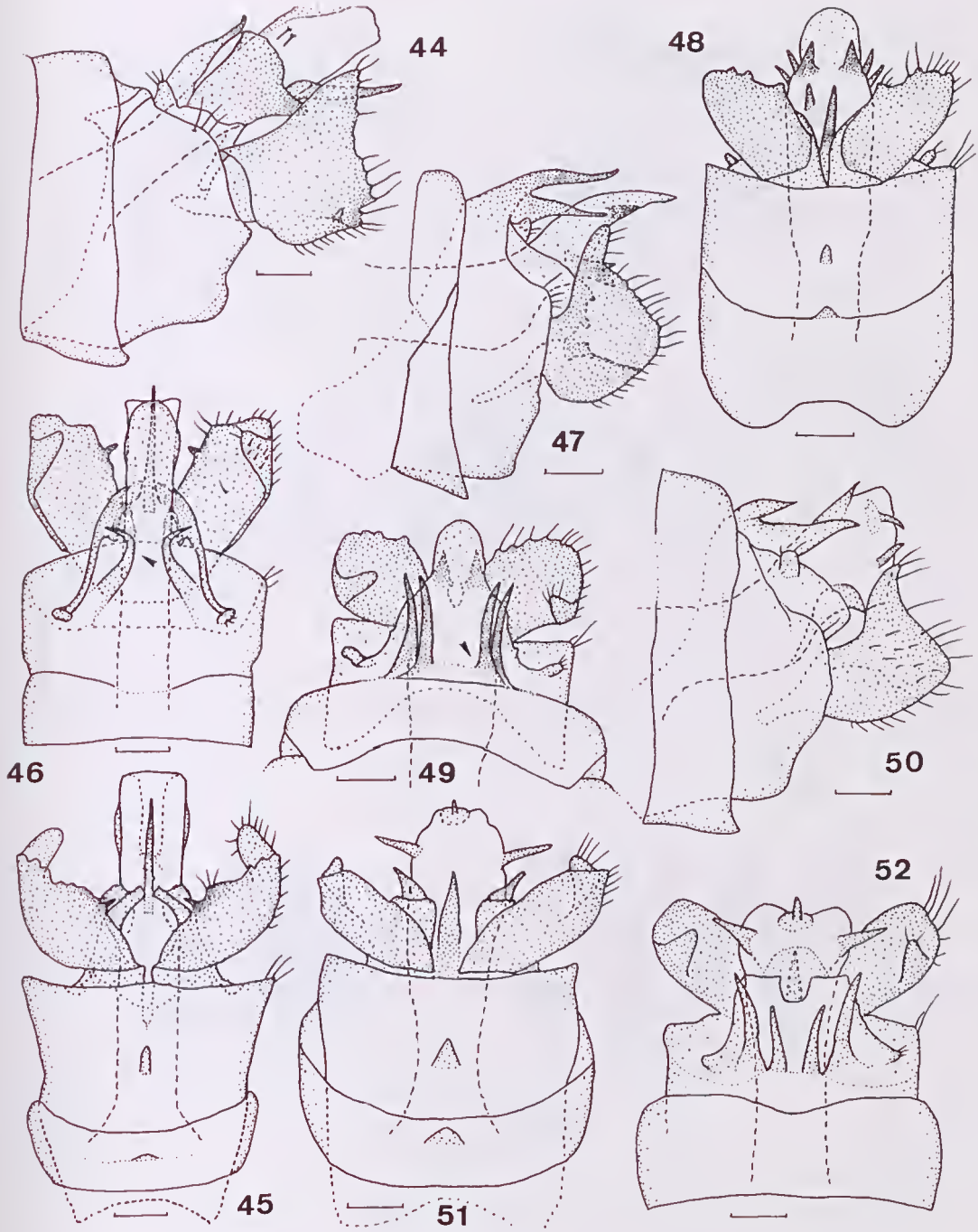

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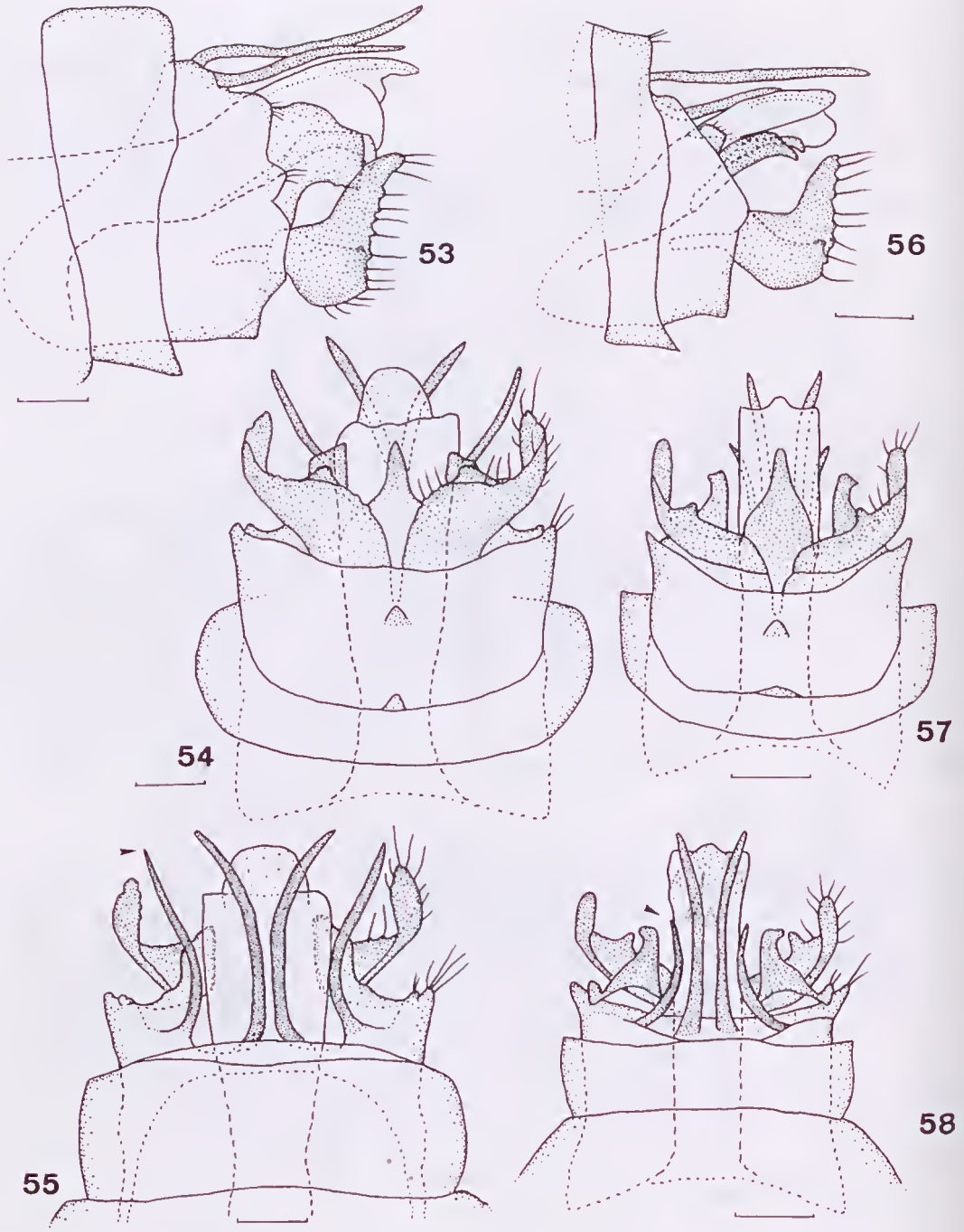
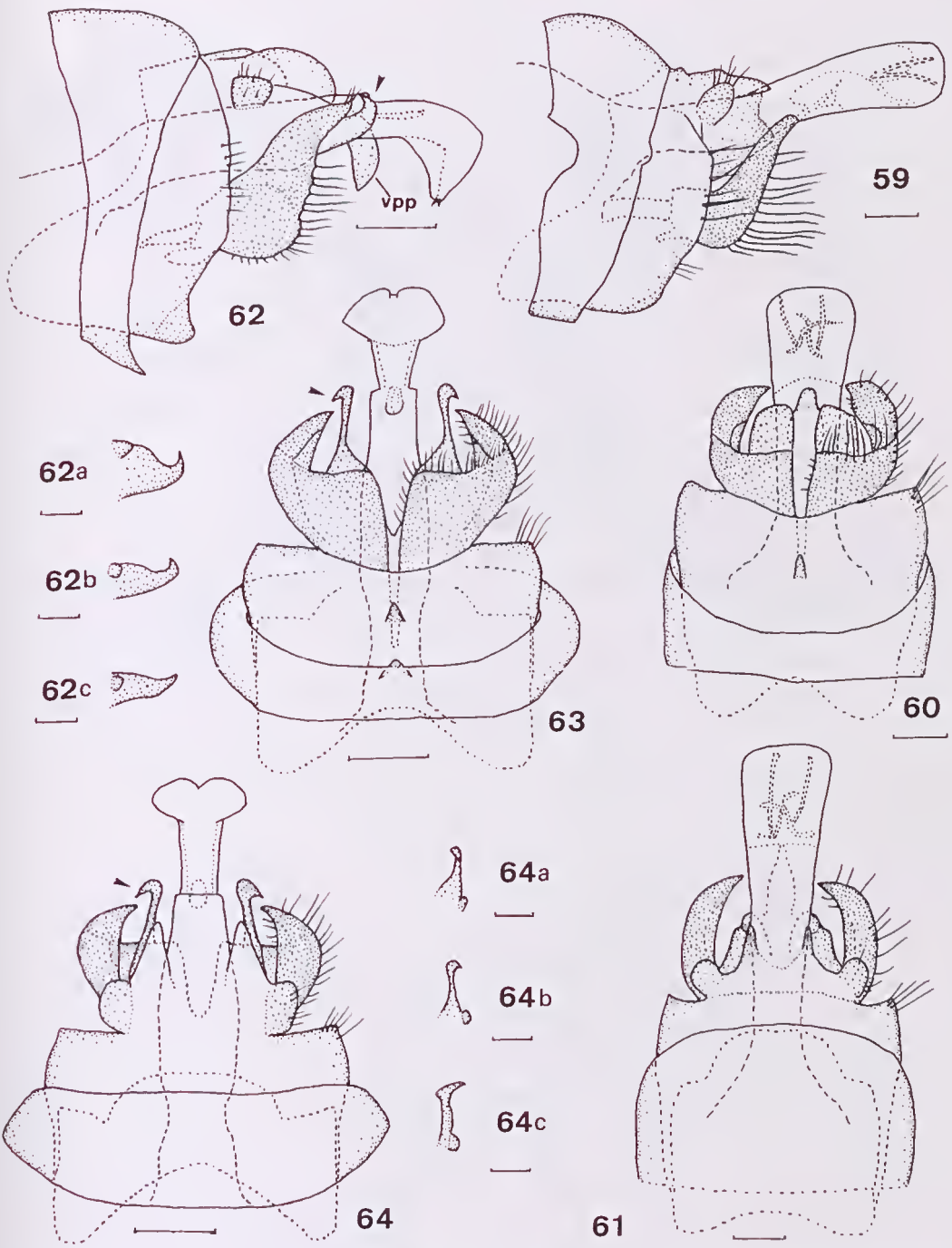


Figures 53–58. *Chimarra* spp. Male genitalia in lateral, ventral and dorsal views. 53–55: *Chimarra akruna* sp. nov. 56–58: *Chimarra pita* sp. nov. Scale lines 0.1 mm.



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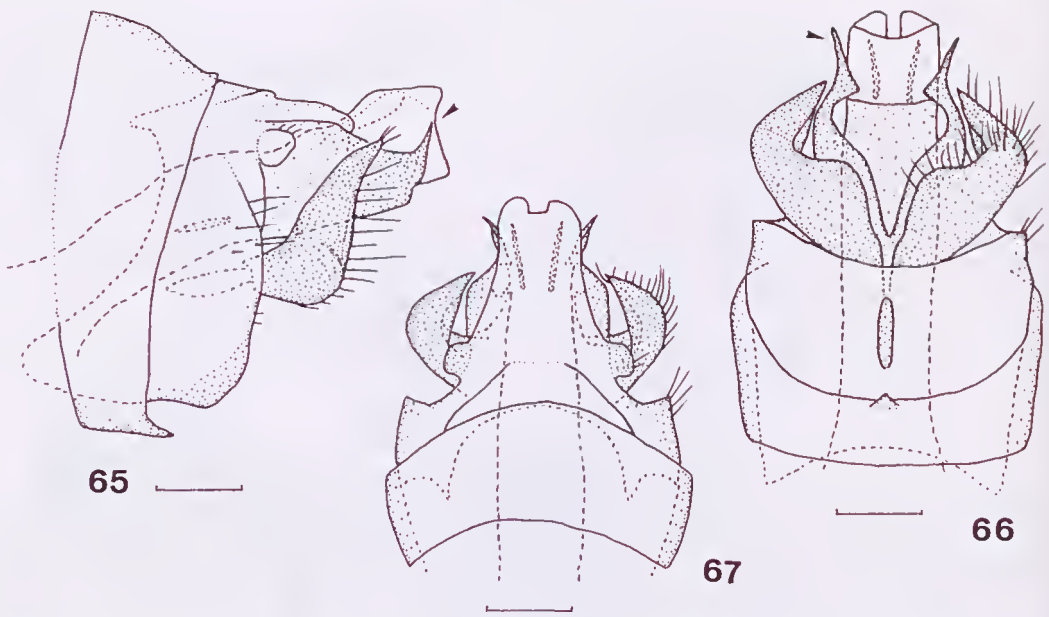
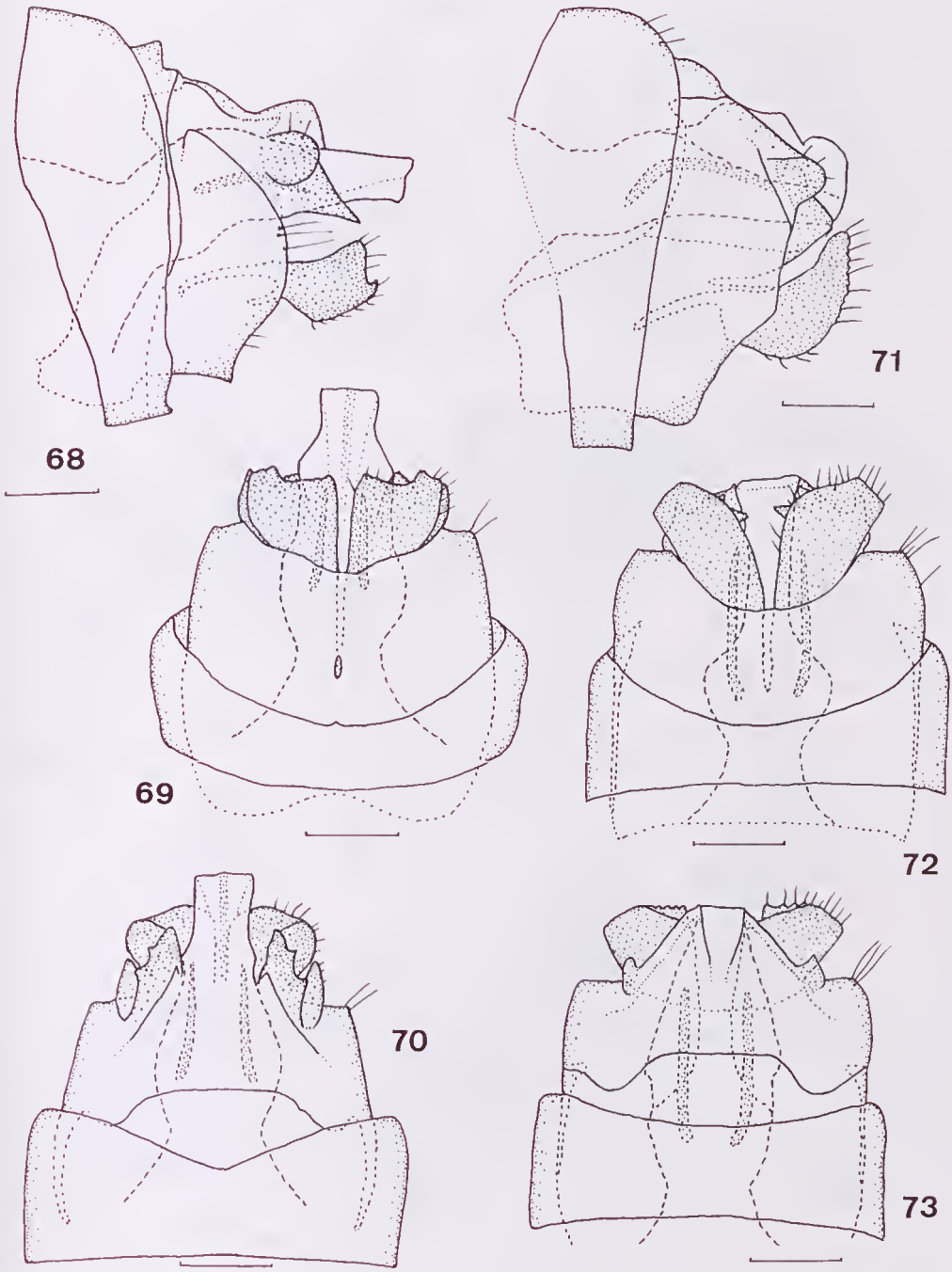


Figures 65–67. *Chimarra* spp. Male genitalia in lateral, ventral and dorsal views. 65–67: *Chimarra kewarra* sp. nov. Scale lines 0.1 mm.



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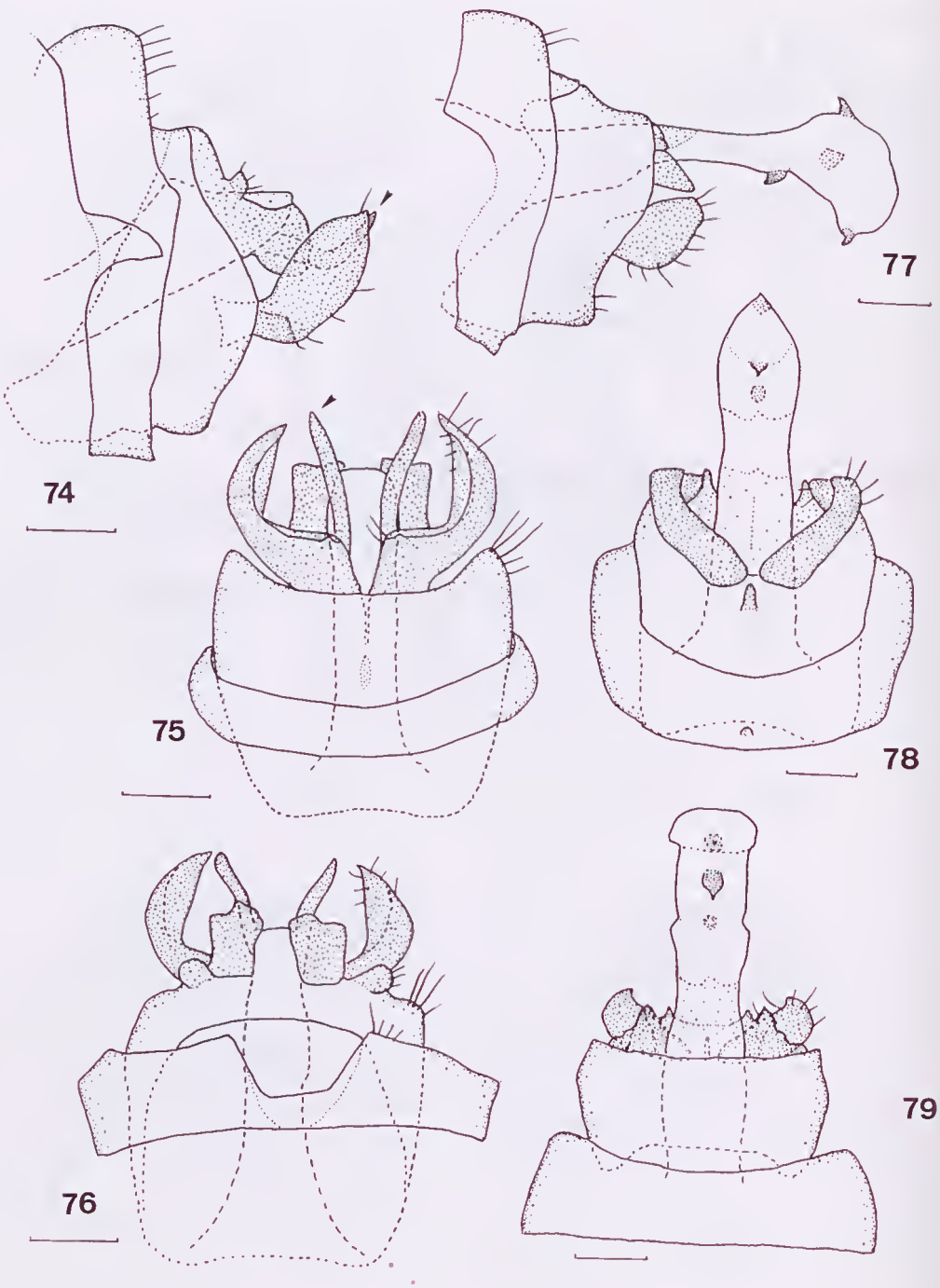
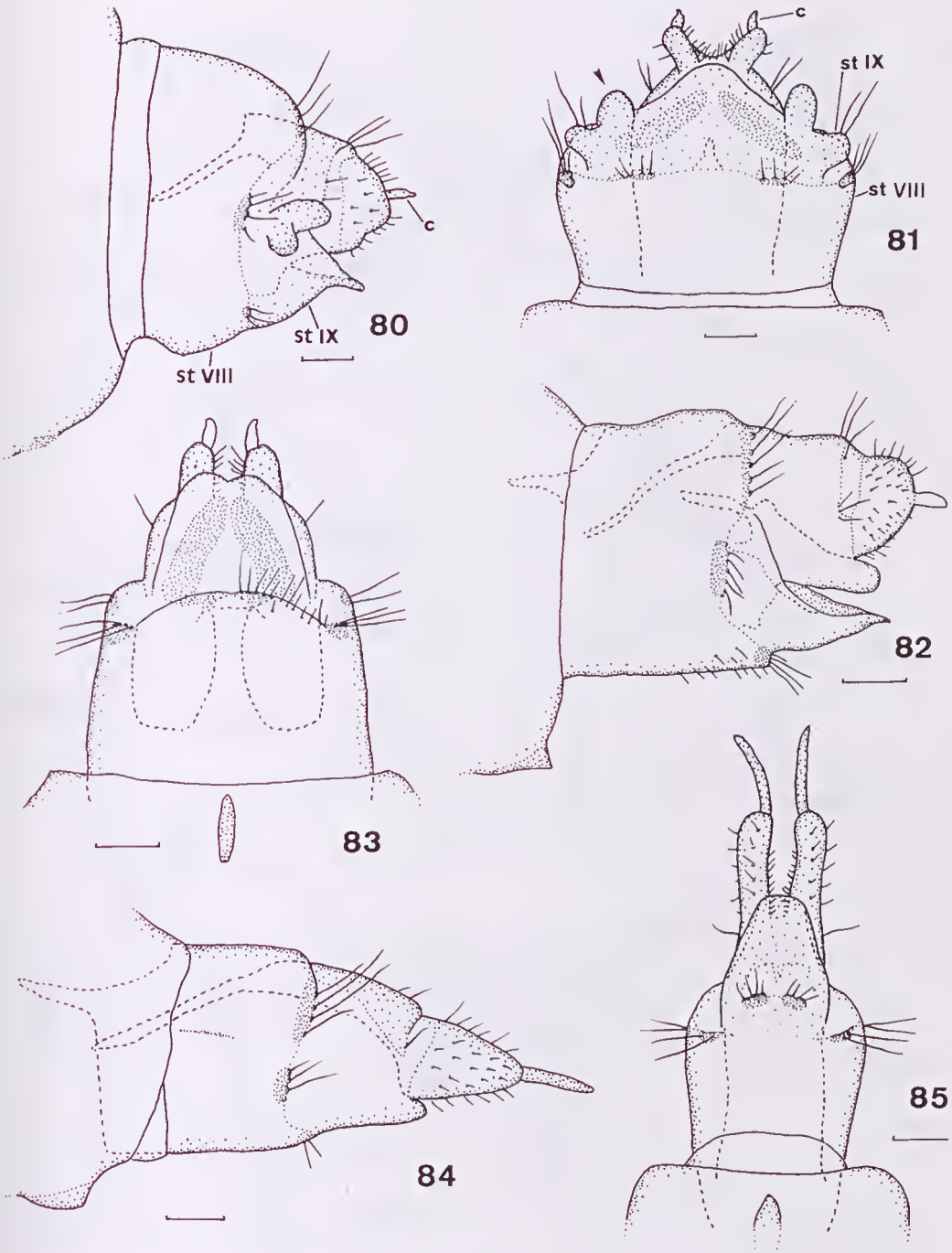
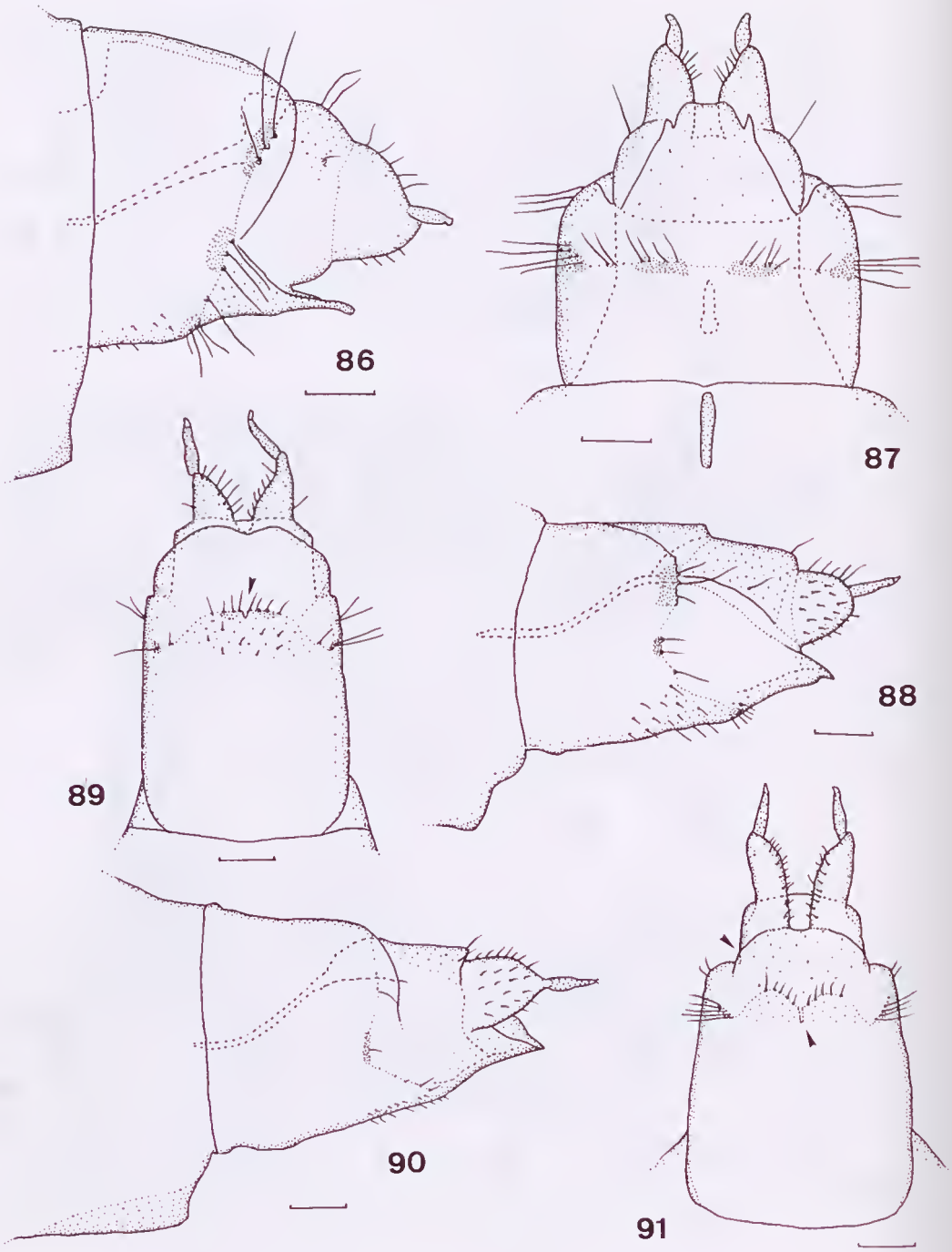


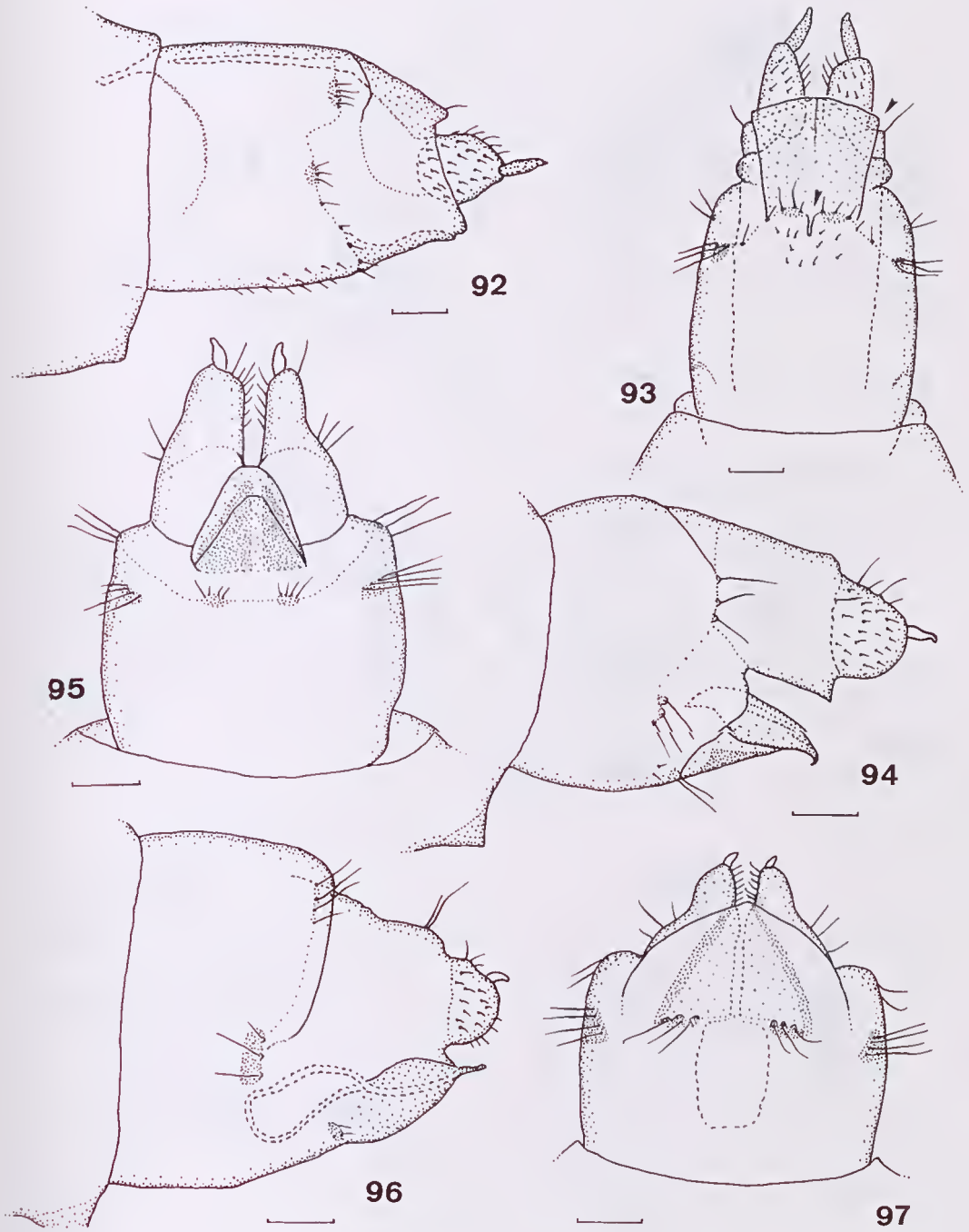
Figures 74–79. *Chimarra* spp. Male genitalia in lateral, ventral and dorsal views. 74–76: *Chimarra bibaringa* sp. nov. 77–79: *Chimarra karakara* sp. nov. Scale lines 0.1 mm.



Figures 80–85. *Chimarra* spp. Female genitalia in lateral and ventral views. 80–81: *Chimarra luminaris* sp. nov. 82–83: *Chimarra locolo* sp. nov. 84–85: *Chimarra orumbera* sp. nov. Abbreviations: c, cercus; st VIII, sternum abdominal segment VIII; st IX, sternum abdominal segment IX. Scale lines 0.1 mm.



Figures 86–91. *Chimarra* spp. Female genitalia in lateral and ventral views. 86–87: *Chimarra kaiya* sp. nov. 88–89: *Chimarra yandala* sp. nov. 90–91: *Chimarra bungoona* sp. nov. Scale lines 0.1 mm.



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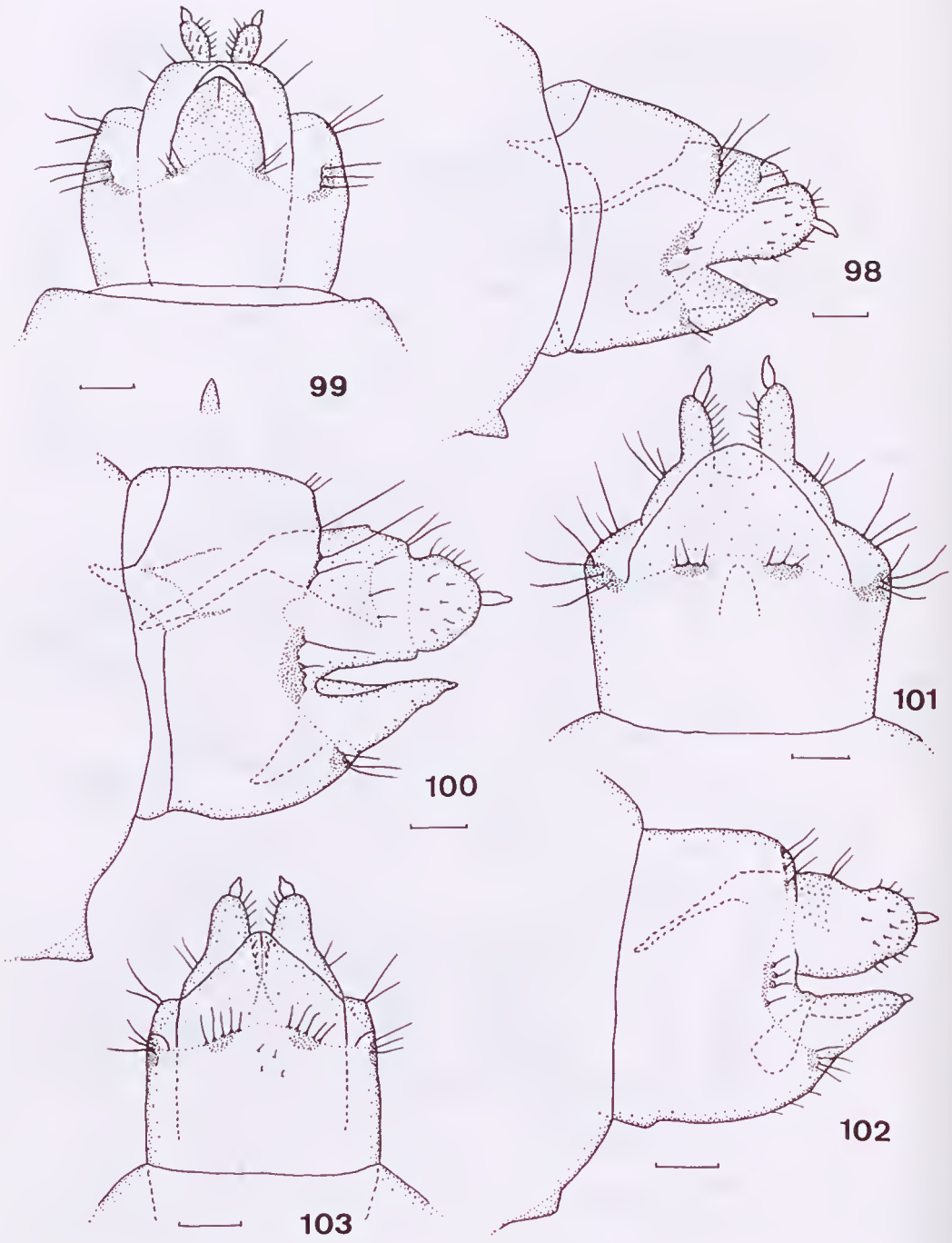

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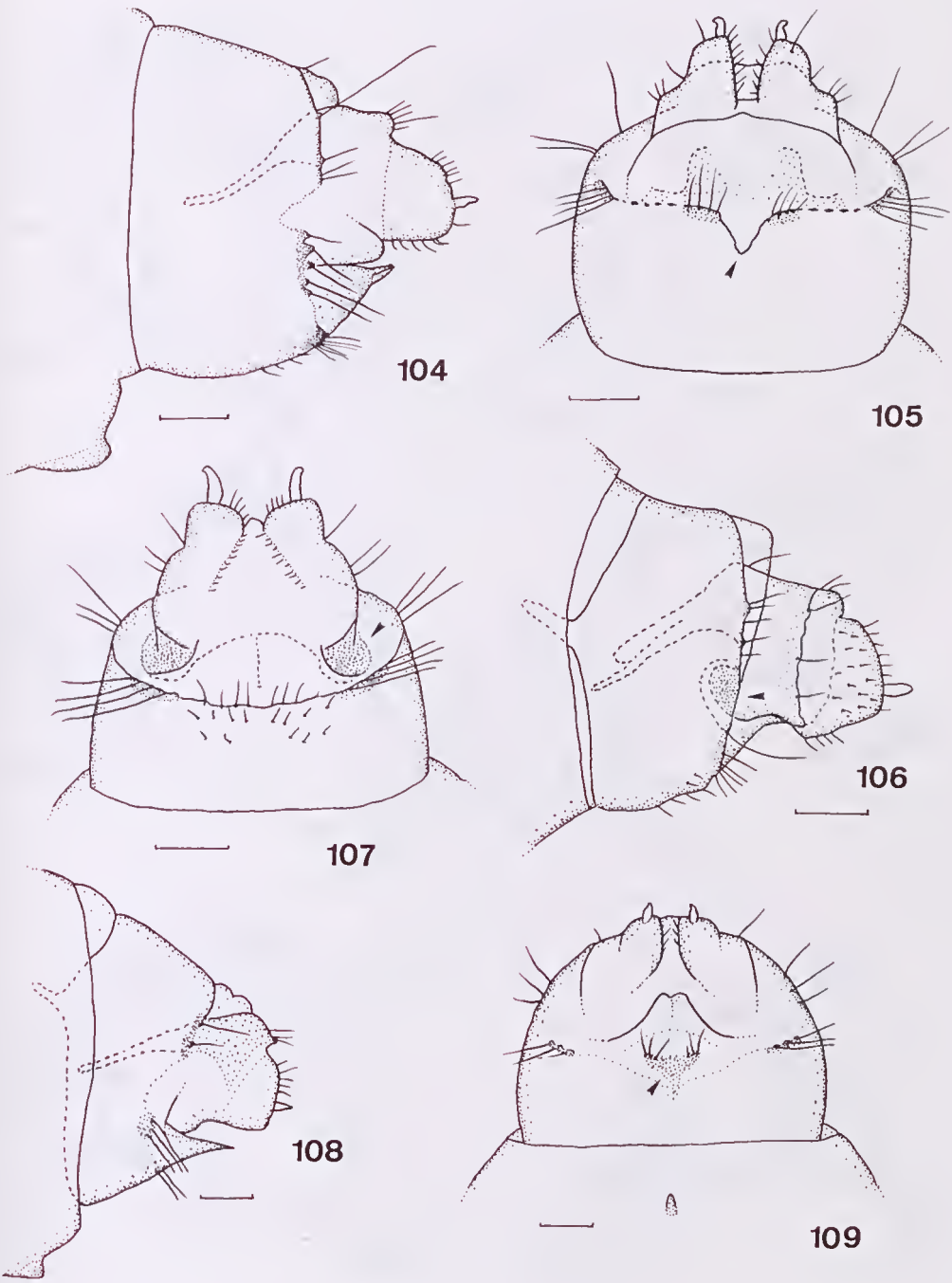
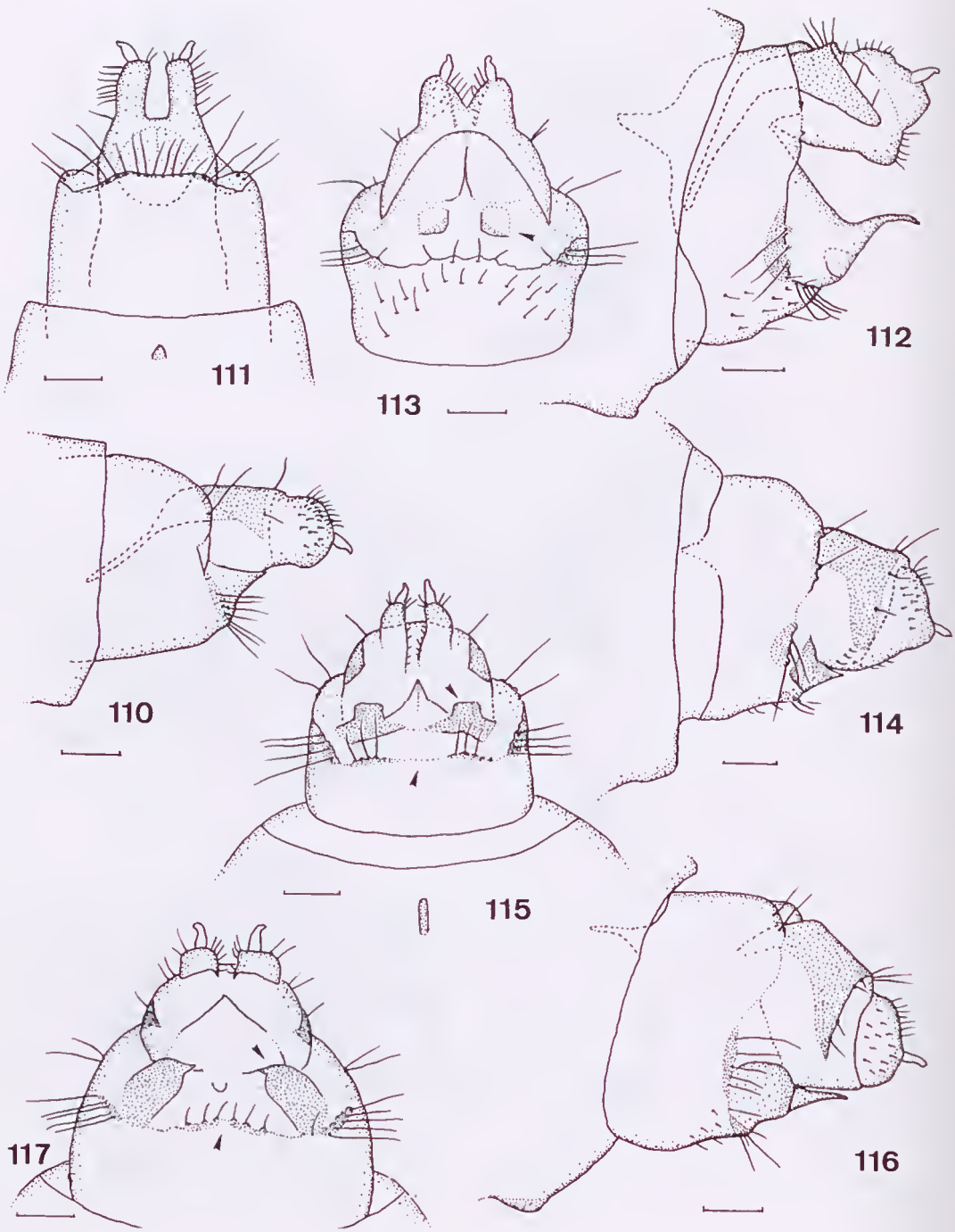
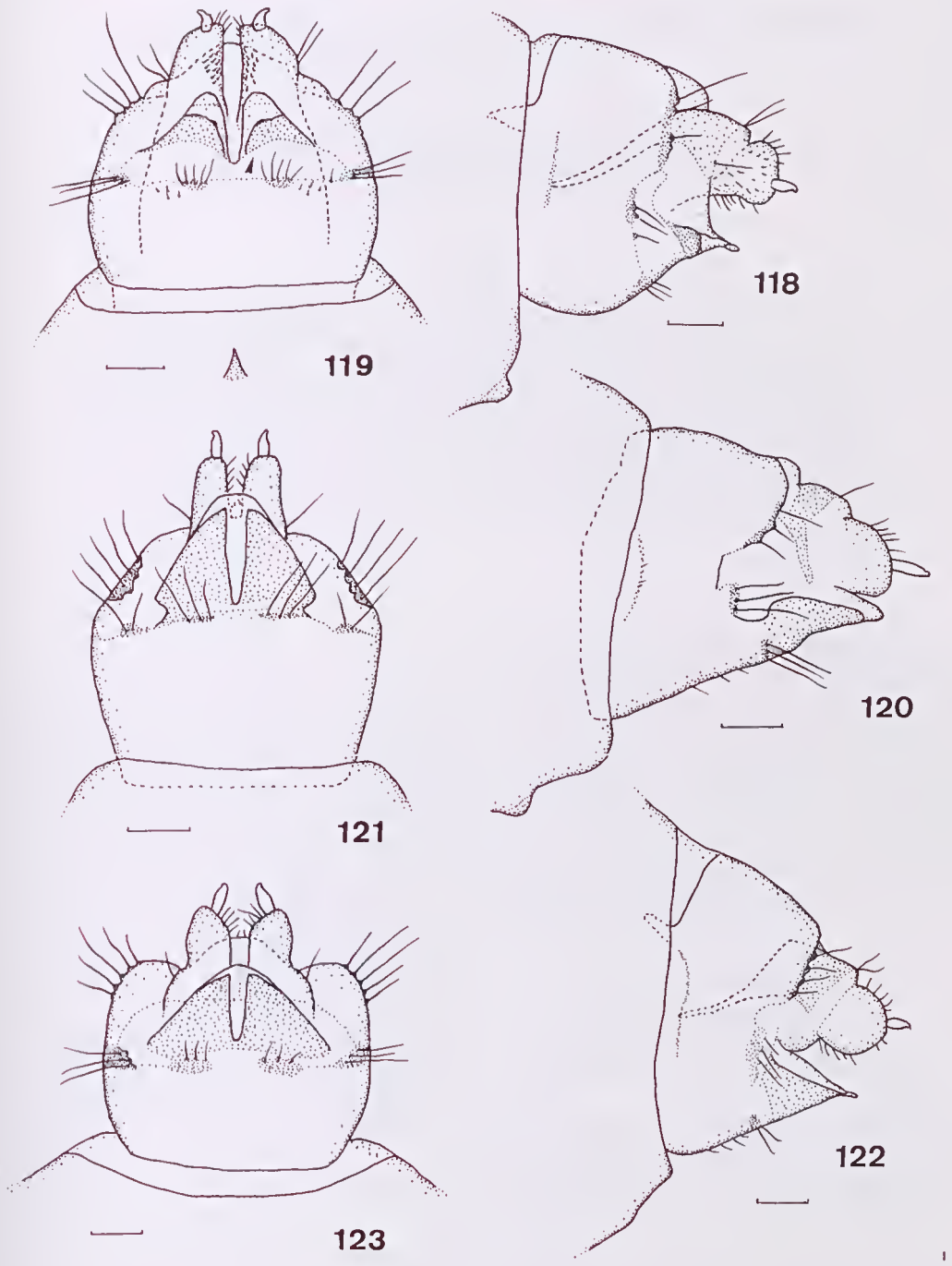


Figures 104–109. *Chimarra* spp. Female genitalia in lateral and ventral views. 104–105: *Chimarra natalicia* sp. nov. 106–107: *Chimarra tallawalla* sp. nov. 108–109: *Chimarra neboissi* sp. nov. Scale lines 0.1 mm.



Figures 110–117. *Chimarra* spp. Female genitalia in lateral and ventral views. 110–111: *Chimarra wooroonoonan* sp. nov. 112–113: *Chimarra stelairae* sp. nov. 114–115: *Chimarra mouldsi* sp. nov. 116–117: *Chimarra karakara* sp. nov. Scale lines 0.1 mm.



Figures 118–123. *Chimarra* spp. Female genitalia in lateral and ventral views. 118–119: *Chimarra australica* Ulmer. 120–121: *Chimarra kewarra* sp. nov. 122–123: *Chimarra monticol*a Kimmins. Scale lines 0.1 mm.

Memoirs of the Museum of Victoria 59(2): 439–455 (2002)

FIVE ARTOTROGIDS (CRUSTACEA: COPEPODA: SIPHONOSTOMATOIDA) FROM EASTERN ANTARCTICA

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Abstract

Johnsson, R. and Rocha, C.E.F., 2002. Five artotrogids (Crustacea: Copepoda: Siphonostomatoida) from Eastern Antaretica. *Memoirs of Museum Victoria* 59(2): 439–455

Five speeies of Artotrogidae are reported from Enderbyland, Eastern Antaretiea. Four are new speeies belonging to the genera *Sestropontius, Bradypontius, Arctopontius* and *Neobradypontius*; *Pseudotrogus uncinatus* (Brady, 1910) is redeseribed. The new speeies of *Sestropontius* differs from its only congener in the armature of P1, P2 and P4. In *Bradypontius* the new speeies differs from other speeies in the armature of P1 and the setation of the maxillule. The number of segments in the antennule and modifieations on the distal element of the antenna distinguish the new speeies of *Neobradypontius* from its congeners. In *Arctopontius* the number of segments in the antennule is the key difference between speeies.

Introduction

The family Artotrogidae was revised by Eiselt (1961) and since then new speeies have been added from Korea (Kim, 1996), the Aretie Oeean (Eiselt, 1986), Madeira I. (Johnsson, 2001) and southern Australia (MeKinnon, 1988). MeKinnon (1988) treated Artotrogidae in the sense of Sars, 1915, i.e. taxa possessing only three pairs of swimming legs, while the speeies studied in the present paper deals with Artotrogidae in the broader sense, those with four pairs of swimming legs. A seeond speeies of *Sestropontius* Giesbreeht is deseribed, more than a eentury after the first. A new speeies is added to *Bradypontius* Geisbreeht, increasing the number of known speeies to 21. *Neobradypontius*, ereeted by Eiselt (1961) with speeies belonging to other genera has its first new speeies deseribed. The genus *Arctopontius* Sars has now three speeies and *Pseudotrogus uncinatus* (Brady, 1910) is redeseribed.

Due to the rarity of Artotrogidae most of the speeies were partially disseeted and these appendages were clarified with laetie aeid, stained with Chlorazol Blaek and mounted on slides with CMC-9 mounting medium. The drawings were made with an Olympus CM30 mieroseope equipped with a camera lueida.

Armature formulae for swimming legs are shown with outer margin first and Roman numerals indieating spines and Arabie numerals setae, aeeording to Huys and Boxshall (1991). Armature for eaudal setae: I – anterolateral aeeessory seta, II – anterolateral seta, III – posterolateral seta, IV – outer terminal seta, V – inner terminal seta, VI – terminal aeeessory seta and VII – dorsal seta, aeeording to Huys and Boxshall (1991). Given the faet that the material is taken from sled samples some elements from the armature of the antennules may have been lost. All material is deposited in Museum Vietoria, Melbourne, Australia (NMV).

Artotrogidae Brady

Sestropontius Giesbreeht

Sestropontius uckinuoui Johnsson, sp. nov.

Figures 1–2

Material examined. Holotype. Southern Oeean, off Enderbyland, Antaretica (65°56.40S, 50°52.10E), 365 m, silt and bryozoan shell, M. Norman, 15 Nov 1985, WHOI epibenthie sled (stn HRD 10), NMV J47289-a (female).

Description. Female: Body length (exeluding eaudal setae) 2.41 mm, greatest body width 1.17 mm, and 2.1 times as long as wide (fig. 1a). Body shape eyelopiform, eephalosome and pedigerous somite 2 with pointed epimera. Pedigerous somite 3 with lateral margins bearing sensilla and

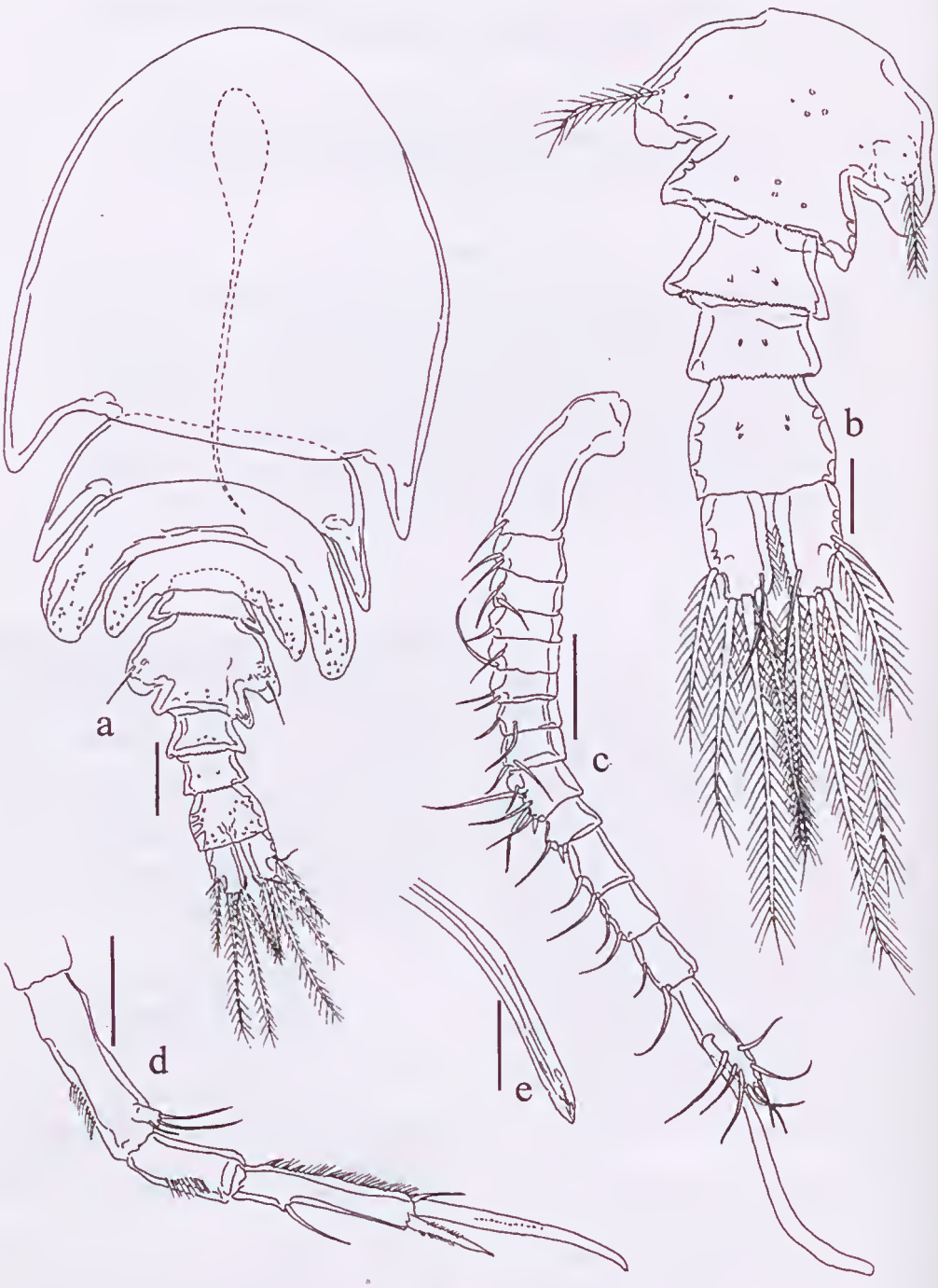

Figure 1. *Sestropontius mckinnoni* sp. nov.; female holotype, a: habitus dorsal showing siphon (dotted line), b: urosome (not showing first somite), c: antennule, d: antenna, e: distal part of mandible. Scale bars: a: 200 µm; b–d: 100 µm; e: 50 µm.

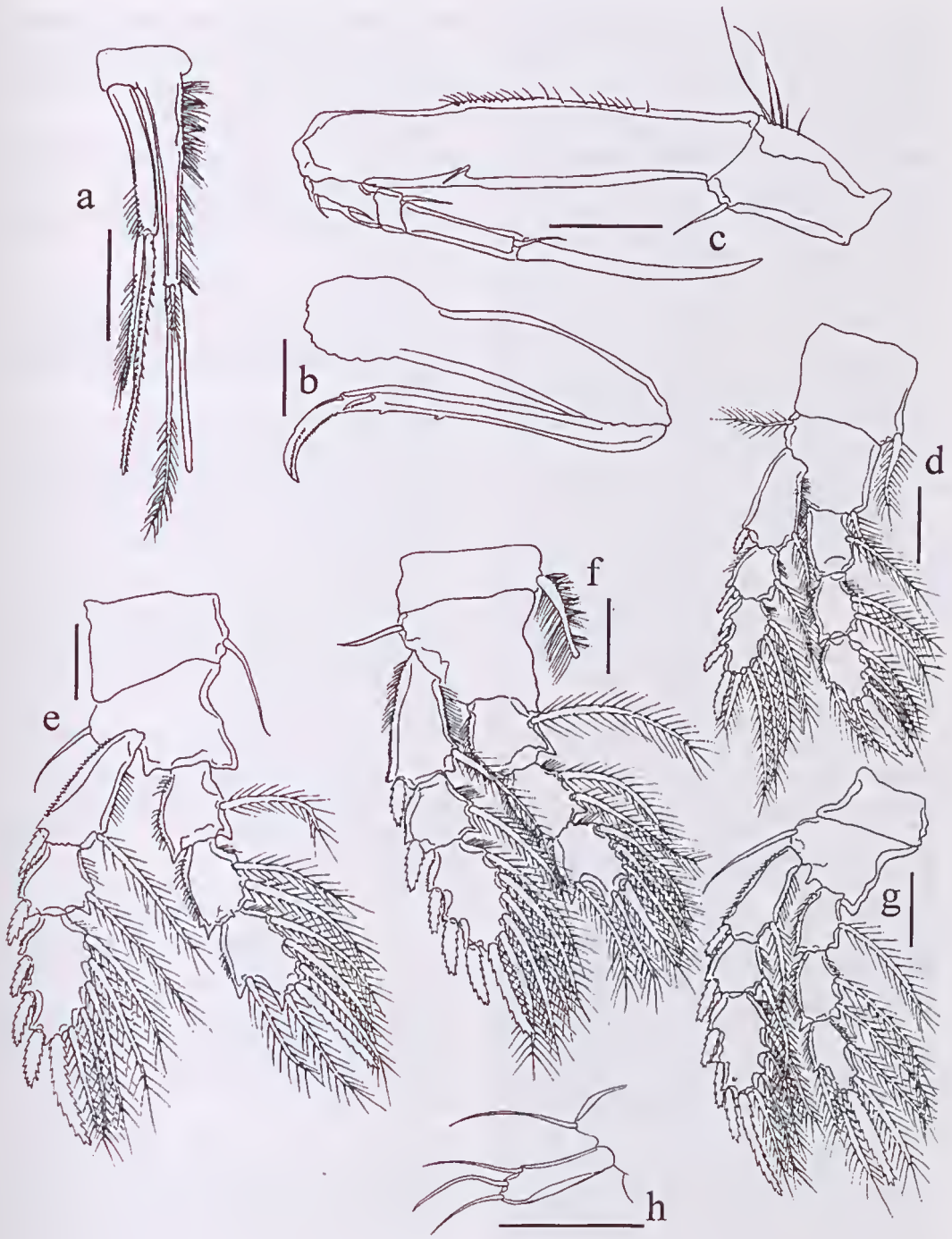

Figure 2. *Sestropontius mckinnoni* sp. nov.; female holotype, a: maxillule, b: maxilla, c: maxilliped, d: P1, e: P2, f: P3, g: P4, h: P5. Scale bars: 100 μm.

reaching genital double-somite. Pedigerous somite 4 also with sensilla on projected margins. Length:width ratio of prosome 1.3. Ratio of length prosome:urosome 1.8.

Urosome (fig. 1b) with 5 somites, all with sensillae. Genital double-somite 296 x 429 µm, length:width ratio 0.7, rounded anterolaterally, armed with plumose seta near laterally projected genital opening. Posterior margin serrated. Three postgenital somites 117 x 229 µm, 117 x 208 µm and 167 x 200 µm, length:width ratios 0.5, 0.6 and 0.8 respectively. First and second postgenital somites with posterior margins serrated. Caudal rami, 154 x 92 µm, 1.7 times as long as wide, with row of hairs on inner margin and armed with 6 setae. Setae I absent. Lengths of setae II–VII, 117, 217, 308, 521, 354 and 162 µm respectively. Setae III–VI plumose, setae II and VII smooth. Setae II and III located medially.

Antennule (fig. 1c) 906 µm long, 14-segmented. Lengths of segments measured along their posterior margins 189 µm (117 µm along anterior margin) 43, 46, 39, 29, 26, 31, 34, 49, 34, 63, 57, 57 and 117 respectively. Segmental homologies and setation as follows: I-1; II-2; III-2; IV-2; V-2; VI-2; VII-2; VIII-2; IX-XIII-5+spine; XIV-1+spine; XV-XVI-2; XVII-XVIII-2; XIX-XX-2; XXI-XXVIII-8+ae. All setae smooth. Aesthetase on segment XXI 278 µm long.

Antenna (fig. 1d) 647 µm long (including distal seta), with basis 178 µm long. Endopod 2-segmented; first segment 100 µm long, unarmed; second segment 167 µm long and armed with 1 smooth seta proximally and 2 setae distally close to a claw-like element, 203 µm long. Exopod 1-segmented, 25 µm long, bearing 3 setae.

Oral cone (fig. 1a) produced into long siphon-like distal portion, 1.2 mm long, 0.5 times body length. Mandible (fig. 1e) comprising stylet bearing distally many small teeth, palp absent. Maxillule (fig. 2a) bilobed, inner lobe 189 µm long, armed with a smooth stout seta, a short plumose seta and a distally plumose seta, inner lateral margin covered with setules. Outer lobe 139 µm long, armed with a pinnate seta and a plumose and pinnate seta.

Maxilla (fig. 2b) syncoxa 521 µm long; claw 588 µm long, curved distally, bearing seta subdistally, 2 small teeth on outer margin and claw tip serrated. Maxilliped (fig. 2e) 5-segmented; syncoxa 144 µm long and bearing short seta on inner margin and long setules on outer margin; basis 417 µm long, with small seta subdistally on inner margin. Endopod 3-segmented, segments 1 to 3 measuring 72, 19 and 111 µm long respectively. First endopod segment with 2 setae; second and third segments with short seta distally; third segment with claw 225 µm long.

Swimming legs 1–4 (P1–P4, figs 2d–g) biramous, with 3-segmented rami. Armature formula of P1–P4 shown in Table 1.

Fifth leg (fig. 2h) with smooth seta near insertion of free segment which bears 2 distal, 1 subdistal seta.

Male: Unknown.

Etymology. The species is dedicated to Dr David McKinnon (Australian Institute of Marine Sciences) who studied artotrogids from southern Australia.

Remarks. The genus *Sestropontius* has, so far, a single species, *Sestropontius bullifer* Giesbrecht, 1899, described from the Mediterranean Sea from a single male. More recently, Stock (1965) described the female. It is possible to find many differences between this and the new species.

Sestropontius mckinnoni shows the third endopod segment of P1 and P2 with the armature 1, 1+1, 3 and the third exopod segment of P4 with eight segments. In *Sestropontius bullifer* the third endopod segment of P1 and P2 shows 1, 2, 3 as armature, and the third exopod segment of P4 has nine segments (Giesbrecht, 1899). *Sestropontius mckinnoni* has three setae on the third exopod of the antenna instead of two as in *S. bullifer*. In *S. bullifer* the antennule is 8-segmented without the aesthetase while the new species has 13 segments with an aesthetase on the last one.

Bradypontius Giesbrecht

Bradypontius poorei Johnsson, sp. nov.

Figures 3–4

Material examined. Holotype. Southern Ocean, off Enderbyland, Antarctica (65°56.40′S, 50°52.10′E), 365 m, silt and bryozoan shell, M. Norman, 15 Nov 1985, WHOI epibenthic sled (stn HRD 10), NMV J48687 (female).

Description. Female: Body length (excluding caudal setae) 1.65 mm, greatest body width 0.80 mm, and twice as long as wide (fig. 3a). Body shape cyclopiform, prosome covered with sensilla, cephalosome with rounded epimera. Pedigerous somites 2–4 with lateral margins projected. Length:width ratio of prosome 1.4. Ratio of lengths of prosome:urosome 2.1.

Table 1. Armature formulae of P1–P4 of five species of Artotrogidae.

Sestropontius mckinnoni sp. nov.	coxa	basis	exopod	endopod
P1	0-1	1-1	I-1; I-1; III,1,4	0-1; 0-2; 1,1+1,3
P2	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,1+1,3
P3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
P4	0-0	1-0	I-1; I-1; III,1,4	0-1; 0-2; 1,1+1,2
Bradypontius poorei sp. nov.				
P1	0-1	1-1	I-1; I-1; III,1,3	0-1; 0-2; 1,2,3
P2	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,1+1,3
P3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,1+1,3
P4	0-0	1-0	I-1; I-1; III,1,5	0-1; 0-2; I
Neobradypontius akanthakontus sp. nov				
P1	0-1	1-1	I-1; I-1; III,1,4	0-1; 0-2; 1,2,3
P2	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
P3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
P4	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,2
Arctopontius novenarius sp. nov.				
P1	0-1	1-1	I-1; I-1; III,2,3	0-1; 0-2; 1,2,3
P2	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
P3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3
P4	0-1	1-0	I-1; I-1; III,1,4	0-1; 0,2,3
Pseudotrogus uncinatus (Brady, 1910)				
P1	0-1	1-0	I-1; I-1; III,2,3	0-1; 0-2; 1,2,3
P2	0-1	1-0	I-1; I-1; III,1,2	0-1; 0-2; 1,2,3
P3	0-1	1-0	I-1; I-1; III,1,5	0-1; 0-2; 1,2,3

Urosome (fig. 3b) with 5 somites. Genital double-somite 174 x 254 µm, length:width ratio 0.7, rounded anterolaterally, smooth seta near genital opening. Three postgenital somites 58 x 143 µm, 71 x 125 µm and 116 x 161 µm, length:width ratios 0.4; 0.6 and 0.7 respectively. Anal somite, caudal rami bearing sensilla. Caudal rami elongate, 134 x 71 µm, almost twice as long as wide, armed with 6 setae. Setae I absent. Lengths of setae II–VII, 89, 98, 281, –, 134 and 62 µm respectively. Setae V broken on both rami. Setae III–VI plumose, setae II and VII smooth. Setae III located subdistally.

Antennule (fig. 3e) 419 µm long not including setae, 8-segmented. Lengths of segments measured along posterior margins 94 µm (69 µm along anterior margin) 119, 31, 19, 29, 25, 32 and 70 respectively. Segmental homologies and setation as follows: I-1; II-VIII-8; IX-XIII-1+spine; XIV-1+spine; XV-XVI-1; XVII-XVIII-2; XIX-XX-2; XXI-XXVIII-12+ae. All setae smooth. Aesthetasc on segment XXI 162 µm long.

Antenna (fig. 3d) 240 µm long (including distal seta), with basis 52 µm long. Endopod 2-segmented; first segment 44 µm long, unarmed; second segment 56 µm long and armed with 1 plumose seta proximally, 1 seta subdistally and 2 distal plumose setae. None modified as a claw-like element. Exopod 1-segmented, 7 µm long, bearing 2 setae.

Oral cone (fig. 3a) produced into siphon-like distal portion, 615 µm long, 0.4 times body length. Mandible (fig. 3e) comprising stylet bearing distally many teeth, palp absent. Maxillule (fig. 3f) bilobed, both lobes thin and nearly equal in size. Inner lobe 116 µm long, armed with 2 long smooth setae and a short smooth seta, inner margin covered with setules. Outer lobe 100 µm long, armed with 2 long pinnate setae and a short smooth seta.

Maxilla (fig. 3g) with syneoxa 275 µm long; claw 400 µm long, curved distally, armed

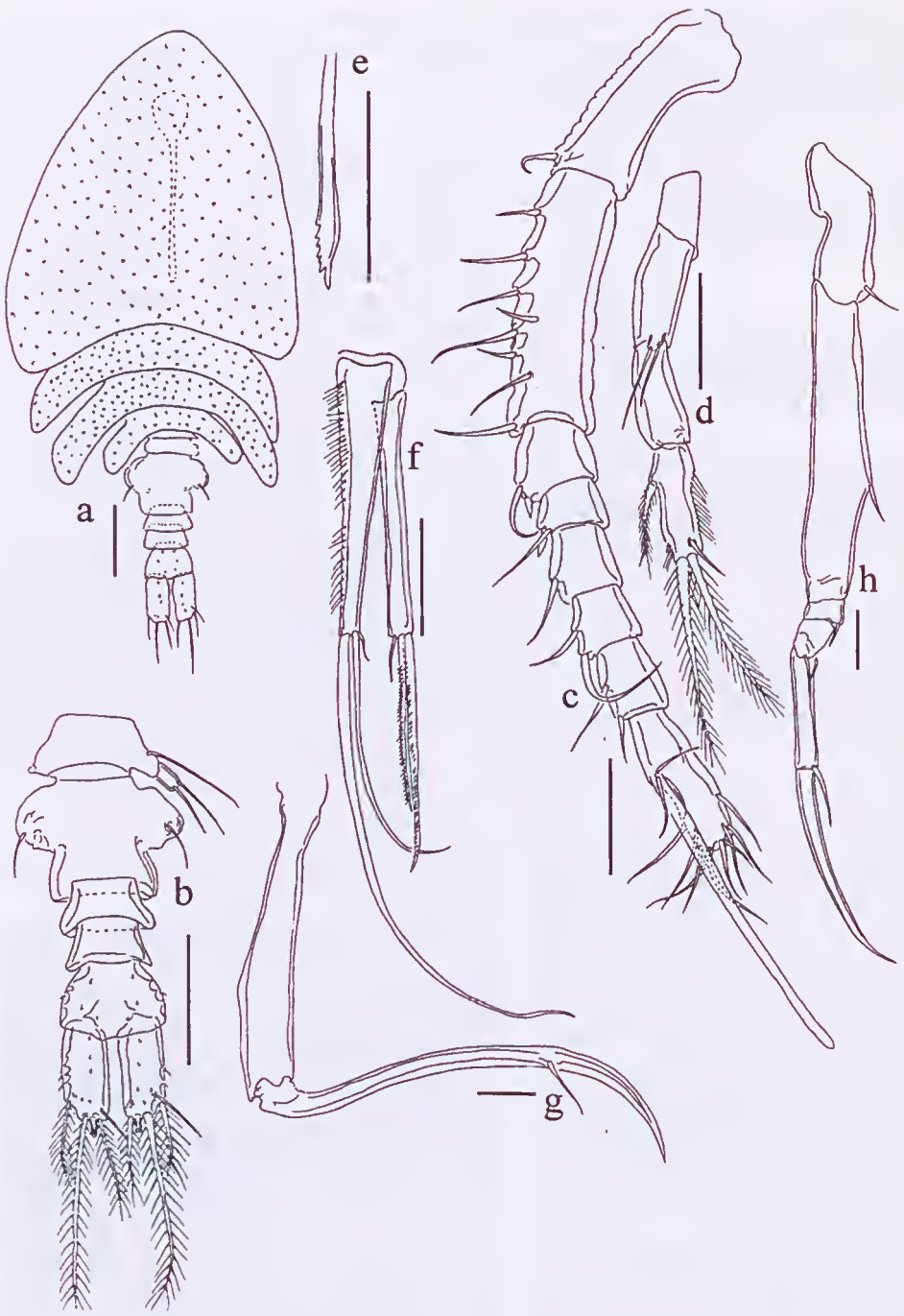

Figure 3. *Bradypontius poorei* sp. nov.; female holotype, a: habitus dorsal showing siphon (dotted line), b: urosome, c: antennule, d: antenna, e: distal part of mandible, f: maxillule, g: maxilla, h: maxilliped. Scale bars: a–b: 200 µm; c–h: 100 µm.

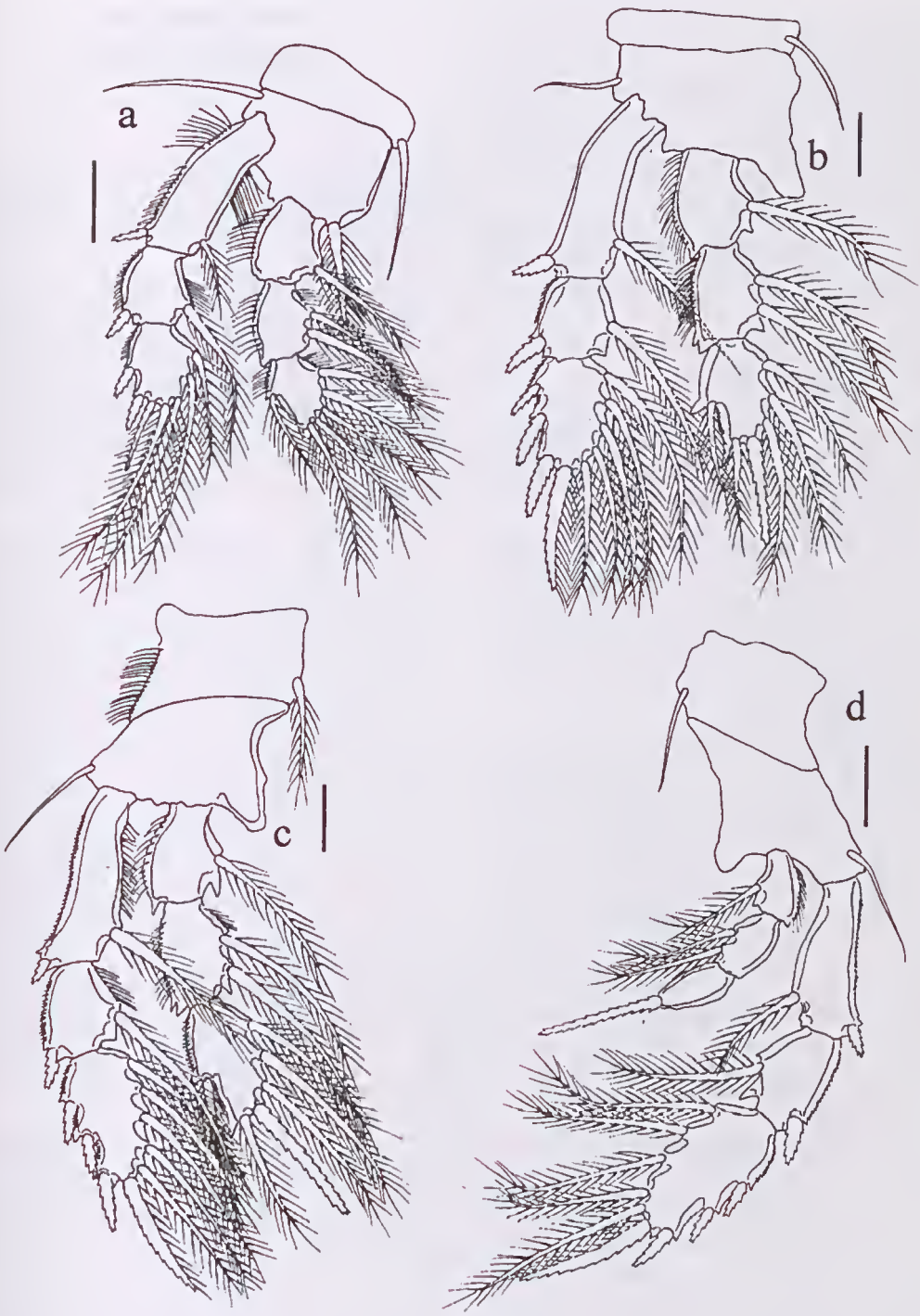

Figure 4. *Bradypontius poorei* sp. nov.; female holotype, a: P1, b: P2, c: P3, d: P4. Scale bars: 50 µm.

with seta subdistally. Maxilliped (fig. 3h) 5-segmented; syncoxa 130 µm long, bearing short seta on inner margin; basis 275 µm long, with small seta medially on inner margin. Endopod 3-segmented, segments 1–3 measuring 30, 42 and 105 µm long respectively. Each endopod segment armed with single seta. Third segment with claw 190 µm long and curved distally.

Swimming legs 1–4 (P1–P4, figs 4a–d) biramous, with 3-segmented rami. Armature formula of P1–P4 shown in Table 1. Third endopodal segment of P4 with setation extremely reduced, bearing single spine.

Fifth leg (fig. 3b) with free segment armed with 2 setae distally.

Male: Unknown.

Etymology. This species is named after Dr Gary Poore, carcinologist of Museum Victoria who has been contributing significantly to the knowledge of the Australian crustacean fauna.

Remarks. The 21 species of *Bradypontius* can be divided according to the number of segments in the antennule which can vary from 8, 9 or more than 10. *Bradypontius poorei* has an 8-segmented antennule as seen in *B. pichoni* Stock, 1966; *B. papillatus* (Scott, 1888) (Sars, 1915); *B. magniceps* (Brady, 1880) (Sars, 1915) and *B. crassisetus* Kim, 1996.

Bradypontius pichoni shows the third endopod segment of P4 armed with two short setae (Stock, 1966) while in *B. poorei* there is only a spine. The remaining segments of the endopod of *B. pichoni* are unarmed while in the new species they have the normal armature of 0-1; 0-2. *Bradypontius pichoni* has the third endopod segment of P2 and P3 with two distal spines instead of one spine and one seta as observed in *B. poorei*. The new species also has three setae on each maxillule lobe while *B. pichoni* has two setae on each. *Bradypontius inermis* Nicholls, 1944 also has the third endopodal segment of P4 with a single element, but the remaining segments of the leg are unarmed (Nicholls, 1944) as in *B. pichoni* and not as in *B. poorei*.

The most distinguishing feature of *Bradypontius poorei* is the third endopod segment of P1 with 7 elements (III-4) instead of 8 (III-5) as seen in all other species of the genus. This feature is one of the characteristics of the genus *Arctopontius*, together with the 2-segmented endopod of P4, according to Eiselt (1961). However in *A. expansus* Sars, 1915 there are two spines and five setae (II-5) (Sars, 1915) and *A. hanseni* Eiselt, 1986 has eight elements (III-5) (Eiselt, 1986).

Neobradypontius Eiselt

Neobradypontius akanthakontus Johnsson, sp. nov.

Figures 5–6

Material examined. Holotype. Southern Ocean, off Enderbyland, Antarctica (65°56.40′S, 50°52.10′E), 365 m, M. Norman, 15 Nov 1985, silt and bryozoan shell, WHOI epibenthic sled (stn HRD 10), NMV J12791 (female).

Description. *Female*: Body length (excluding caudal setae) 1.80 mm, greatest body width 1.39 mm, and 1.3 times as long as wide (fig. 5a). Body dorsoventrally flattened, prosome covered with sensilla, cephalosome and pedigerous somites 2–4 with lateral margins projected. Pedigerous somite 4 projected beyond the posterior margin of the genital double somite. Length:width ratio of prosome 1. Ratio of length of prosome:urosome 3.1.

Urosome (fig. 5b) with 5 somites. Genital double-somite 108 x 196 µm, length:width ratio 0.6, slightly rounded laterally and bearing smooth seta near genital opening, posterior margins posterolaterally projected, reaching second postgenital somite. Three postgenital somites 13 x 88 µm, 21 x 87 µm and 83 x 106 µm, length:width ratios 0.1, 0.2 and 0.8 respectively. Anal somite bearing sensilla. Caudal rami 52 x 42 µm, 1.2 as long as wide and armed with 6 setae. Setae I absent. Lengths of setae II–VII, 42, 54, –, 204, 83 and 38 µm respectively. Setae IV broken in both rami. Setae III–VI plumose, setae II and VII smooth.

Antennule (fig. 5c) 692 µm long, not including setae, 9-segmented. Lengths of segments measured along their posterior margins 139 µm (111 µm along anterior margin) 44, 125, 56, 33, 56, 58, 61 and 119 respectively. Segmental homologies and setation as follows: I-1; II-1; III-VIII-12; IX-XIII-6+spine; XIV-1+spine; XV-XVI-2; XVII-XVIII-2; XIX-XX-2; XXI-XXVIII-13+ae. Third segment showing a suhdivision. All setae smooth. Aesthetasc on segment XXI 444 µm long.

Antenna (fig. 5d) 333 µm long (including distal seta), with basis 89 µm long. Endopod 2-segmented; first segment 59 µm long, unarmed; second segment 109 µm long and armed with 1 plumose seta proximally, 1 smooth seta subdistally and 1 distal plumose setae near insertion of short straight claw 76 µm. Exopod 1-segmented, 28 µm long, hearing 2 setae distally.

Oral cone (fig. 5a) produced into siphon-like distal portion, 478 µm long, 0.3 times body length. Mandible (fig. 5e) comprising stylet

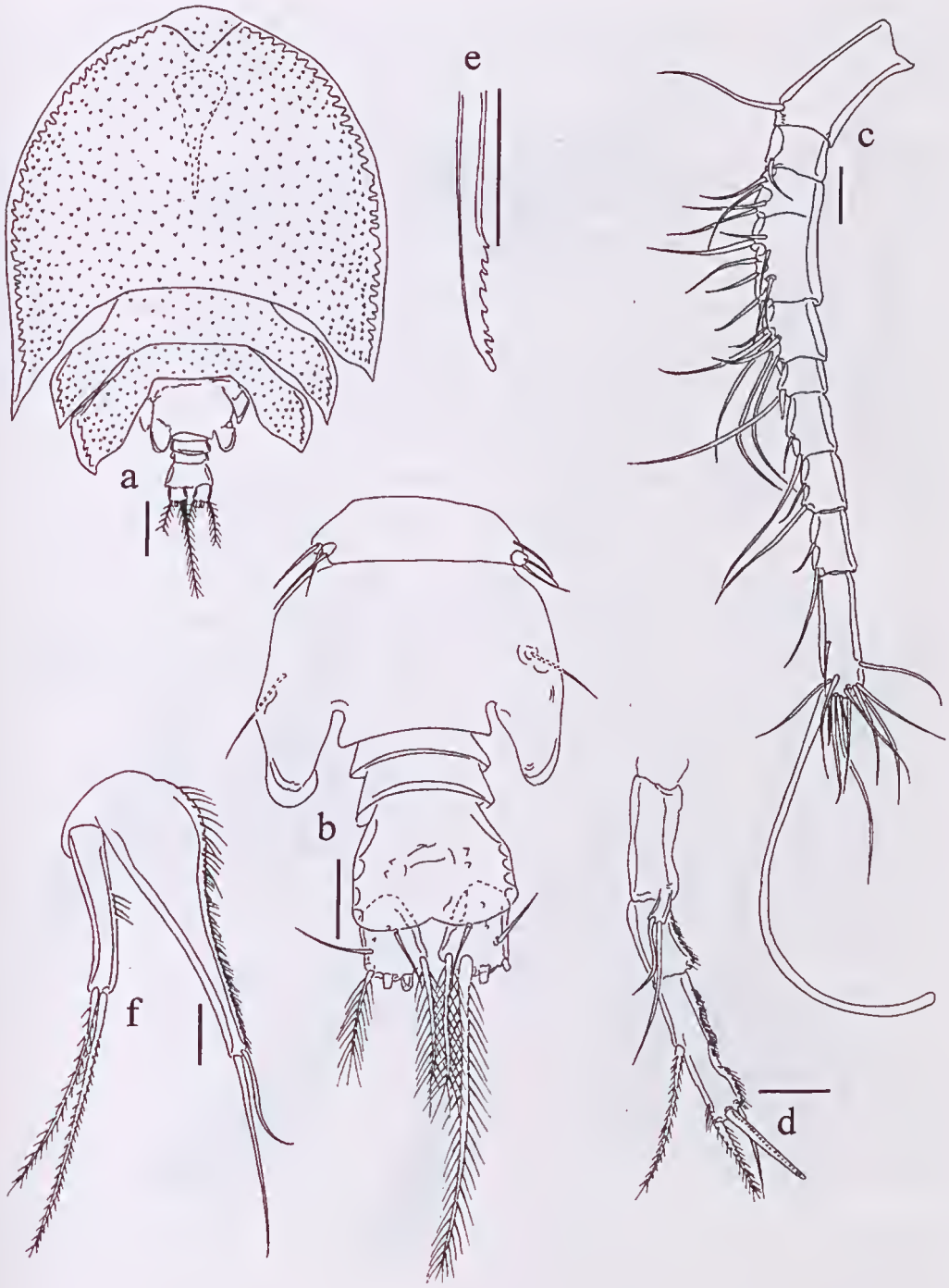

Figure 5. *Neobradypontius akanthakontus* sp. nov.; female holotype, a: habitus dorsal showing siphon (dotted line), b: urosome, c: antennule, d: antenna, e: distal part of mandible, f: maxillule. Scale bars: a: 200 µm; b–f: 50 µm.

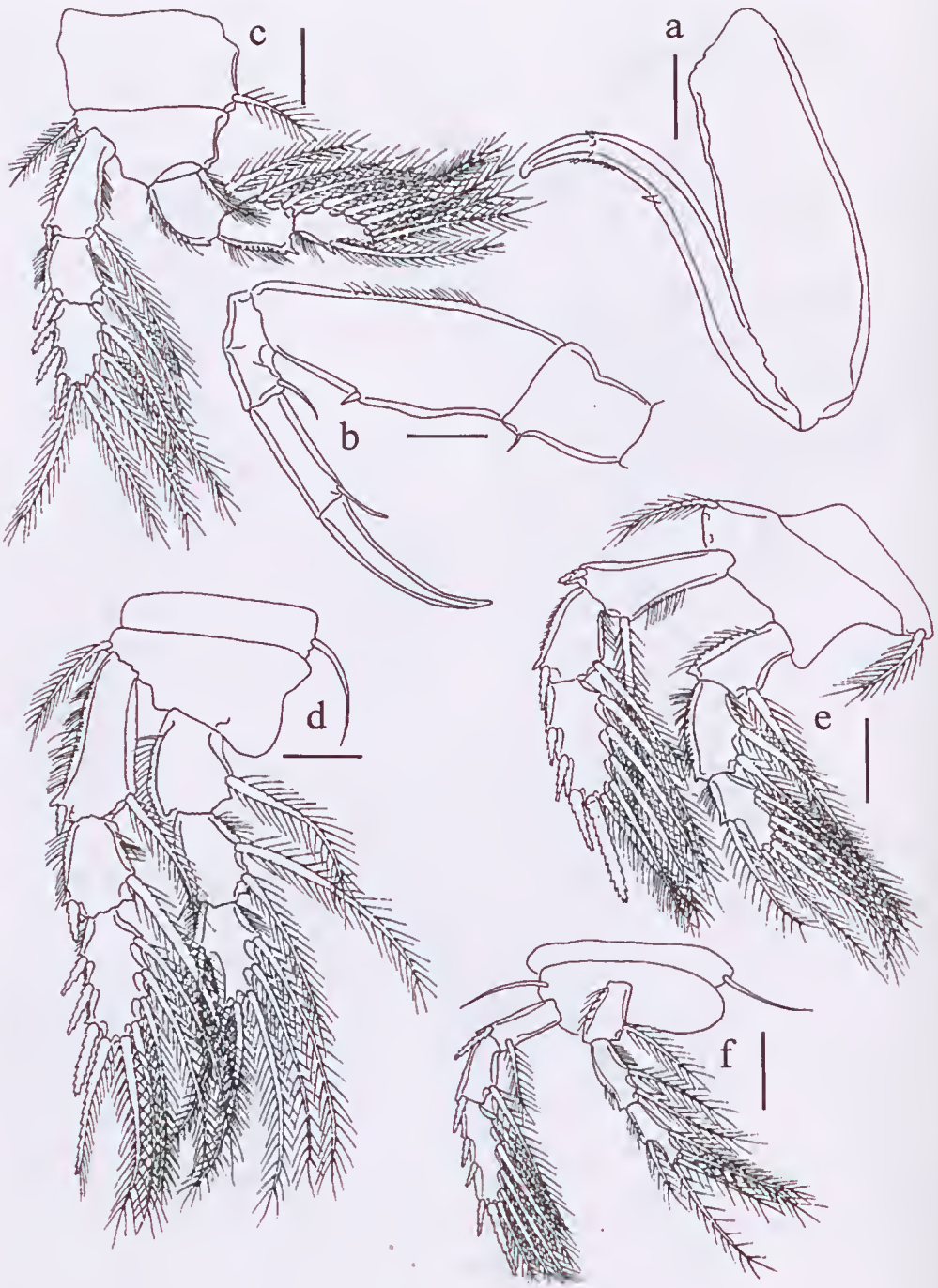

Figure 6. *Neobradypontius akanthakontus* sp. nov.; female holotype, a: maxilla, b: maxilliped, c: P1, d: P2, e: P3, f: P4. Scale bars: 50 µm.

bearing distally many teeth, palp absent. Maxillule (fig. 5f) bilobed. Inner lobe 196 µm long, proximal part enlarged, armed with 2 smooth setae, inner margin covered with setules. Outer lobe 117 µm long, armed with 2 long plumose setae.

Maxilla (fig. 6a) with strong syneoxa 248 µm long; elaw 254 µm long, eurved distally, bearing dentieles subdistally. Maxilliped (fig. 6b) 5-segmented; syneoxa 75 µm long, bearing short seta on inner margin; basis 176 µm long, with small spiniform seta medially on inner margin and setules on outer margin. Endopod 3-segmented, segments 1–3 measuring 50, 37 and 78 µm long respeetively. First endopod segment unarmed. Seeond and third endopod segments armed with single seta. Third segment with elaw 120 µm long, eurved distally.

Swimming legs 1–4 (P1–P4, figs 6e–f) biramous, with 3-segmented rami. Armature formula of P1–P4 shown in Table 1.

Fifth leg (fig. 5b) with small free segment armed with 2 setae distally.

Male: Unknown.

Etymology. From the greek *akantha*, spine or thorn and *kontus*, redueed, referring to the distal short spine from the second endopod segment of the antenna (noun in apposition).

Remarks. Neobradypontius was ereeted by Eiselt (1961) to aeeomodate a group of speeies whieh were previously plaeed in other genera of Artotrogidae but have pleura of the third pedigerous somite extending baekwards, at least to the front edge of the first postgenital somite. *Neobradypontius akanthakontus* is the only speeies of the genus with a 9-segmented antennule. All other speeies have at least a 10-segmented antennule, exeept *N. scaber* (Brady, 1910) whieh has eight segments. No other speeies of the genus has the seeond endopod segment of the antenna with the distal element modified into a spine of similar length to the distal and the subdistal setae.

Arctopontius Sars

Arctopontius novenarius Johnsson, sp. nov.

Figures 7–8

Material examined. Holotype. Southern Ocean, off Enderbyland, Antaretica (65°56.40′S, 50°52.10′E), 365 m, silt and bryozoan shell, M. Norman, 15 Nov 1985, WHOI epibenthic sled (stn HRD 10), NMV J47290 (female).

Description. Female: Body length (exeluding eaudal setae) 2.32 mm, greatest body width 1.25 mm, and 1.9 times as long as wide (fig. 7a). Body with prosome covered with sensilla, eephalosome and pedigerous somites 2–4 with lateral margins rounded and slightly projeeted. Length:width ratio of prosome 1.3. Ratio of lengths of prosome:urosome 2.1.

Urosome (fig. 7b) with 5 somites. Genital double-somite 231 x 323 µm, length:width ratio 0.7, slightly rounded anterolaterally, with smooth seta, posterior margin laterally serrated. Three postgenital somites 100 x 173 µm, 73 x 158 µm and 142 x 192 µm, length:width ratios 0.6; 0.5 and 0.7 respeetively. First postgenital somite with posterior margin of somite serrated, seeond postgenital and anal somites with posterior margin serrated. Anal somite bearing sensilla. Caudal rami, 138 x 85 µm, 1.6 as long as wide and armed with 6 setae. Setae I absent. Lengths of setae II–VII: 96, 162, 481, 731, 235 and 81 µm respeetively. Setae III–VI plumose, setae II and VII smooth. Caudal rami with posterior margin serrated and bearing sensilla.

Antennule (fig. 7e) 631 µm long, not ineluding setae, 9-segmented. Lengths of segments measured along their posterior margins 125 µm (71 µm along anterior margin) 135, 27, 52, 31, 50, 46, 50 and 115 respectively. Segmental homologies and setation as follows: I-1; II-VII-11; VIII-1; IX-XIII-7+spine; XIV-1+spine; XV-XVI-2; XVII-XVIII-2; XIX-XX-2; XXI-XXVIII-11+ae. Aesthetase on segment XXI 260 µm long.

Antenna (fig. 7d) 377 µm long (ineluding distal seta), with basis 82 µm long. Endopod 2-segmented; first segment 55 µm long, unarmed; seeond segment 93 µm long and armed with 1 naked seta proximally, 2 short smooth setae subdistally and 1 distal plumose seta near insertion of long straight elaw 148 µm. Exopod 1-segmented, 18 µm long, bearing 2 setae distally and 1 subdistally.

Oral eone (fig. 7a) produced into siphon-like distal portion, 950 µm long, 0.4 times body length. Mandible (fig. 7e) comprising stylet bearing 2 groups of teeth distally, palp absent. Maxillule (fig. 7f) bilobed. Inner lobe 198 µm long, armed with long, distally plumose seta and short naked seta, inner margin covered with setules. Outer lobe 112 µm long, armed with 2 stout setae, one pinnate.

Maxilla (fig. 7g) with strong syneoxa 535 µm long; elaw 538 µm long, slightly eurved distally. Maxilliped (fig. 8a) 5-segmented; syneoxa 150 µm long, bearing short seta on inner margin; basis 362 µm long, with small seta medially on inner margin. Endopod 3-segmented, segments 1–3 measuring 42, 96 and 123 µm long respeetively.

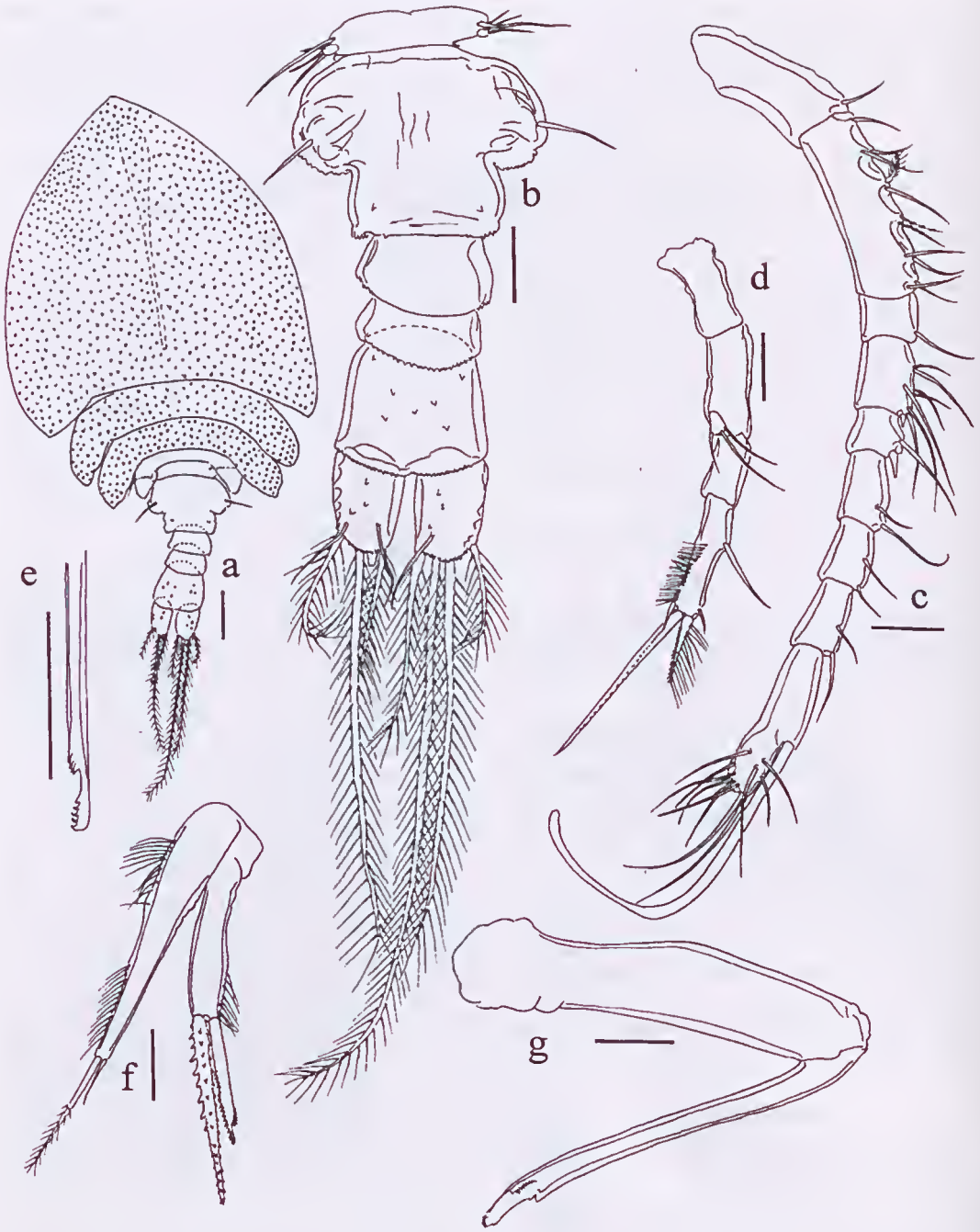

Figure 7. *Arctopontius novenarius* sp. nov.; female holotype, a: habitus dorsal showing siphon (dotted line), b: urosome, c: antennule, d: antenna, e: distal part of mandible, f: maxillule, g: maxilla. Scale bars: a: 200 µm; b, g: 100 µm; c–f: 50 µm.

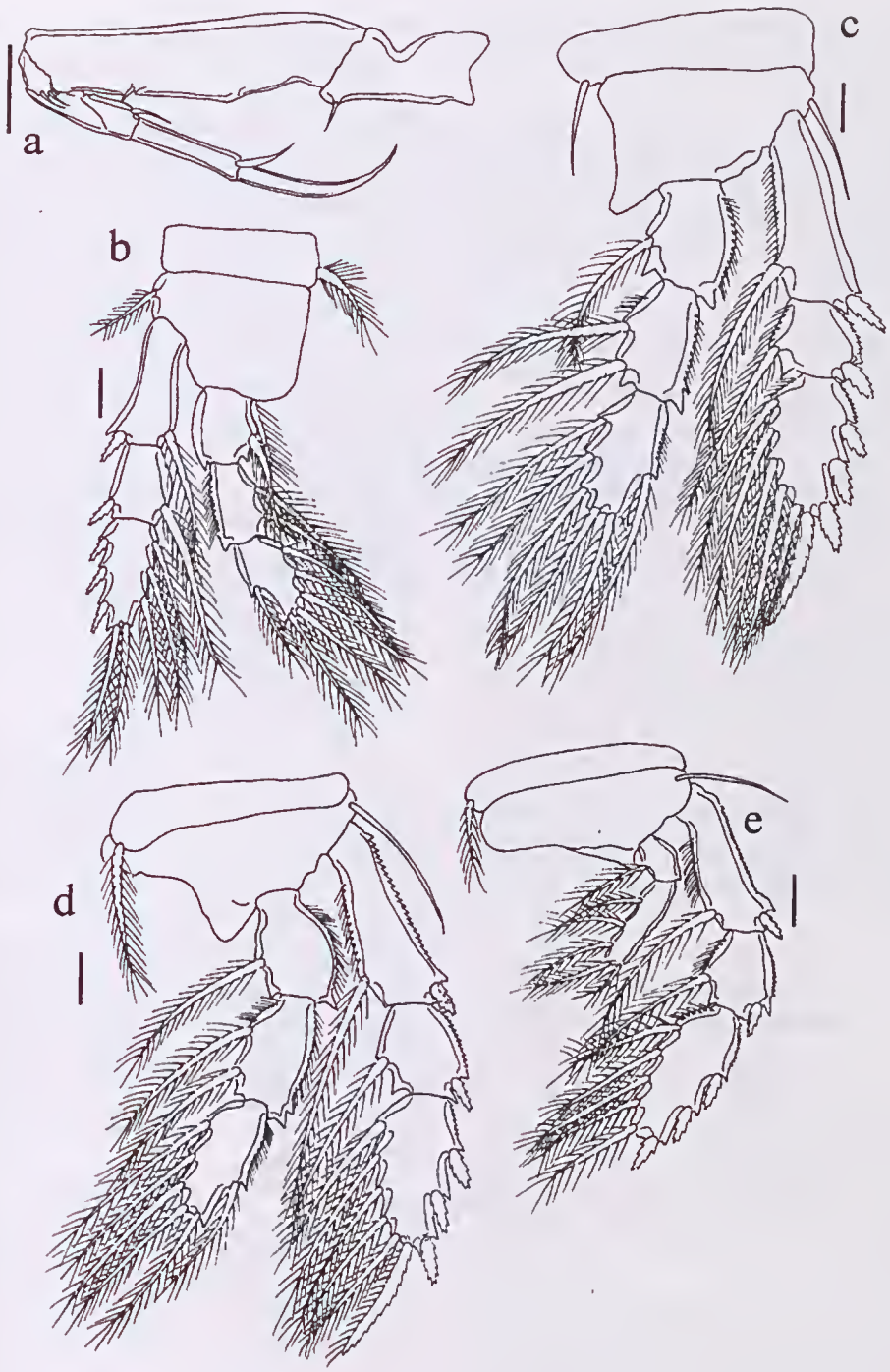

Figure 8. *Arctopontius novenarius* sp. nov.; female holotype, a: maxilliped, b: P1, c: P2, d: P3, e: P4. Scale bars: a: 100 μm; b–e: 50 μm.

First endopod segment bearing 2 setae. Second and third endopod segments armed with single seta. Third segment with claw 200 µm long, curved distally.

Swimming legs 1–4 (P1–P4, figs 8b–e) biramous, P1–P3 with 3-segmented rami. P4 with 3-segmented exopod and 2-segmented endopod. Armature formula of P1–P4 shown in Table 1.

Fifth leg (fig. 7a) with small free segment armed with 2 setae distally, and one subdistally on outer margin.

Male: Unknown.

Etymology. The specific name *novenarius* means "consisting of nine", an allusion to the 9-segmented antennule (noun in apposition).

Remarks. The most distinguishing features of *Arctopontius* are the 2-segmented endopod of P4, the third exopod segment of P1 bearing three setae on the inner margin and only two spines on the outer margin (Sars, 1915). These characteristics were confirmed by Eiselt (1961), but *Arctopontius hanseni* Eiselt, 1986, the second species described for the genus, only shows a 2-segmented endopod and the third endopod of P1 has armature of III,5. *Arctopontius novenarius* shows the same pattern as *A. hanseni* in P1 but the second endopod segment of P4 has setation of 0,2,3, instead of a single seta as in the case of the other two species. *Arctopontius novenarius* differs from its congeners because it has a 9-segmented antennule instead of 8-segmented. This difference originates from the ancestral segment VIII, which is not fused with the previous segment in the new species.

Pseudotrogus Eiselt

Pseudotrogus uncinatus (Brady)

Figures 9–10

Dystrogus uncinatus Brady, 1910: 583, pl. LX figs 1–8 (partim).

Pseudotrogus uncinatus.—Eiselt: 1961: 324, fig. 4.

Material examined. Southern Ocean, off Enderbyland, Antarctica (65°56.40'S, 50°52.10'E), 365 m, silt and bryozoan shell, M. Norman, 15 Nov 1985, WHOI epibenthic sled (stn HRD 10), NMV J47288 (2 females).

Description. *Female*: Body length (excluding caudal setae) 2.07 mm, greatest body width 1.83 mm, and 1.1 times as long as wide (fig. 9a). Body dorsoventrally flattened, prosome covered with sensillae, cephalosome and pedigerous somites 2–4 with lateral margins rounded and projected. Pedigerous somite 3 with lateral margin reaching caudal rami. Length:width ratio of prosome 1. Ratio of lengths of prosome:urosome 6.1.

Urosome (fig. 9b) with 5 somites. Genital double-somite 208 x 308 µm, length:width ratio 0.7, slightly rounded anteriorly and bearing small smooth seta, posterolateral projections unequal, however both projected. Right posterolateral projection reaching distal margin of second postgenital somite, left posterolateral projection reaching caudal rami. Left side bearing an empty ovigerous sac. Three postgenital somites 80 x 176 µm, 52 x 184 µm and 184 x 256 µm, length:width ratio 0.5, 0.3 and 0.7 respectively. All somites of urosome bearing sensillae. Caudal rami slightly as long as wide, 164 x 156 µm, and armed with 6 setae. Setae I absent. Setae III–VI broken. Lengths of setae II and VII: 44 and 76 µm respectively, both smooth.

Antennule (fig. 9c) 668 µm long, not including setae, 9-segmented. Lengths of segments measured along their posterior margins 150 µm (80 µm along anterior margin) 48, 145, 57, 29, 36, 36, 48 and 118 respectively. Segmental homologies and setation as follows: I-1; II-1; III-VIII-6; IX-XIII-5; XIV-1+spine; XV-XVI-2; XVII-XVIII-2; XIX-XX-2; XXI-XXVIII-10+ae. Aesthetasc on segment XXI 170 µm long.

Antenna (fig. 9d) 367 µm long (including distal seta), with basis 105 µm long. Endopod 2-segmented; first segment 68 µm long, unarmed; second segment 97 µm long and armed with 1 plumose seta proximally, 1 smooth seta subdistally and 1 distal seta near insertion of straight claw 97 µm long. Exopod 1-segmented, 27 µm long, bearing 2 setae distally.

Oral cone (fig. 9a) produced into siphon-like distal portion, 556 µm long, 0.3 times the body length. Mandible (fig. 9e) comprising stylet bearing distally a group of teeth, palp absent. Maxillule (fig. 10a) bilobed. Inner lobe 292 µm long, armed with 2 long setae, one distally plumose and short naked seta, inner margin covered with setules. Outer lobe 169 µm long, armed with 2 plumose setae.

Maxilla (fig. 10b) with strong syncoxa 575 µm long; claw 621 µm long, slightly curved distally and bearing short seta subdistally. Maxilliped (fig. 10c) 5-segmented; syncoxa 233 µm long, bearing short seta on inner margin; basis 479 µm long, unarmed. Endopod 3-segmented, segments 1–3 measuring 87, 96 and 150 µm long respectively. All endopod segments bearing a seta. Third segment with claw 233 µm long and curved distally.

Swimming legs 1–3 (P1–P3, figs 10d–f) biramous. P4 reduced to single process bearing 2

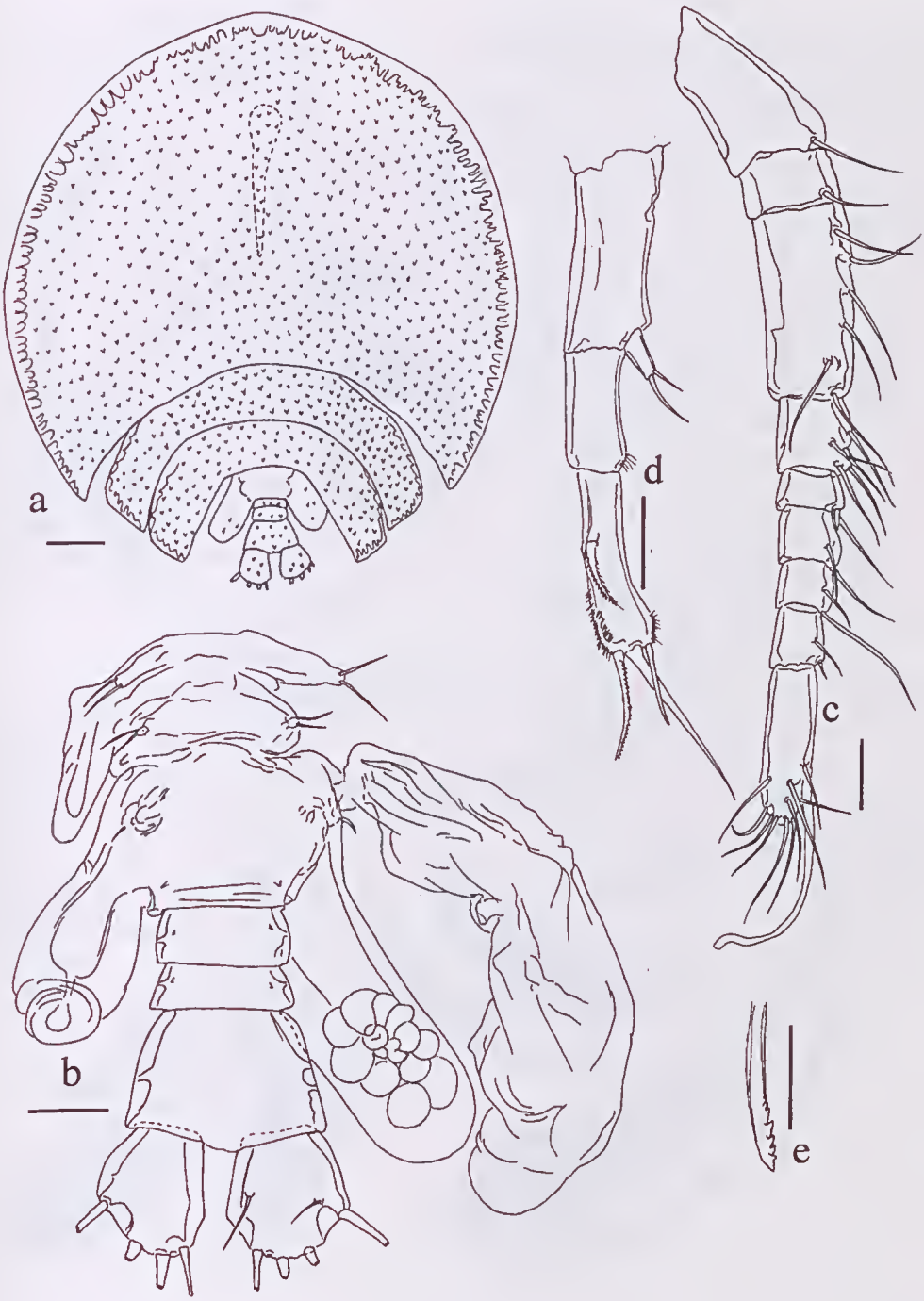

Figure 9. *Pseudotrogus uncinatus* (Brady, 1910); female, a: habitus dorsal showing siphon (dotted line), b: P4 and urosome, c: antennule, d: antenna, e: distal part of mandible. Scale bars: a: 200 µm; b: 100 µm; c–e: 50 µm.

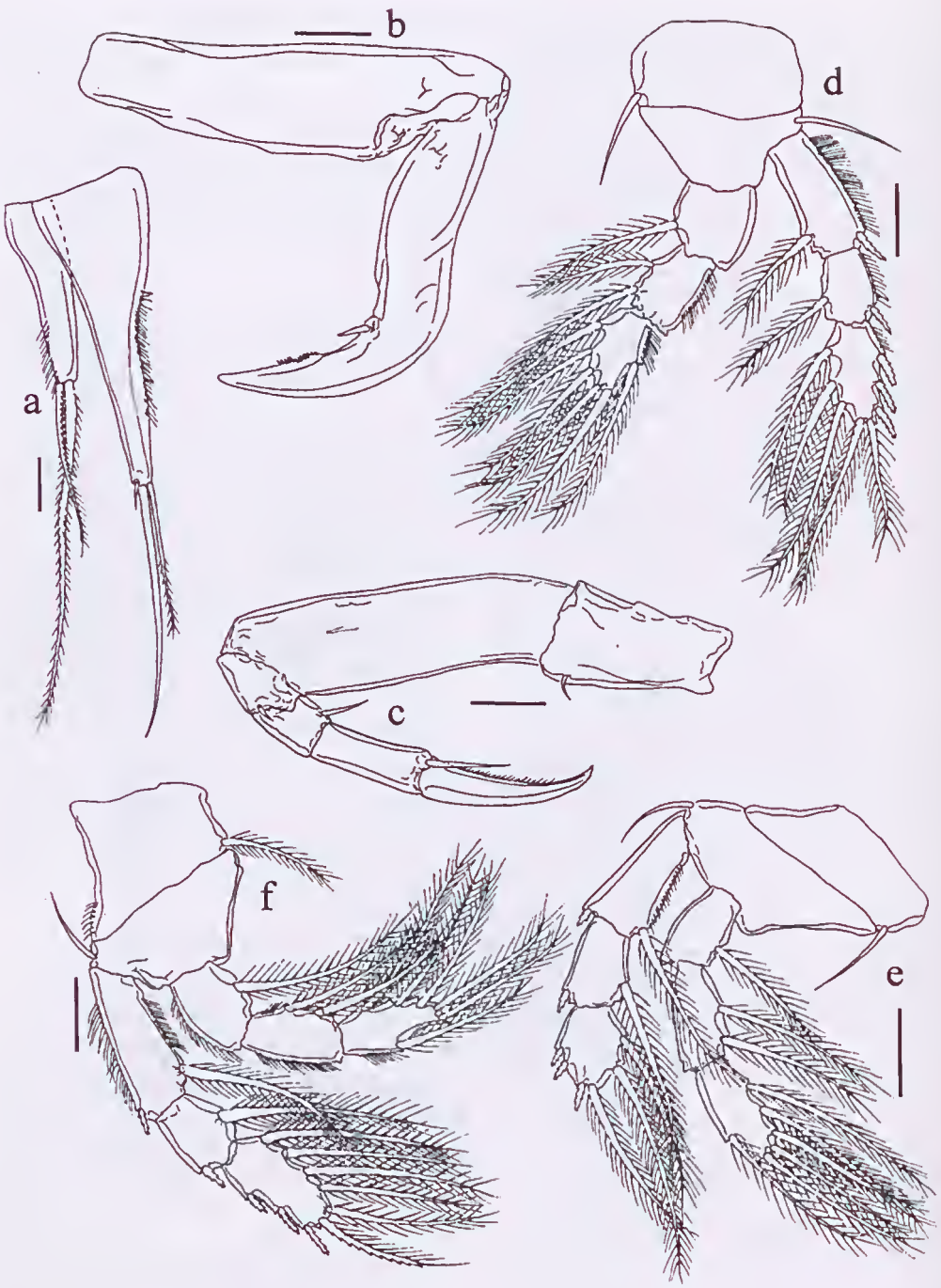

Figure 10. *Pseudotrogus uncinatus* (Brady, 1910); female, a: maxillule, b: maxilla, c: maxilliped, d: P1, e: P2, f: P3. Scale bars: 100 µm.

setae distally (fig. 9b). Armature formula of P1–P3 shown in Table 1.

Fifth leg (fig. 9b) with small free segment armed with 2 setae distally.

Male: Unknown.

Remarks. Pseudotrogus uncinatus was described by Brady (1910) based on a specimen recorded from the Gauss-Station during the Deutschen Südpolar-Expedition in 1902. Later, Eiselt (1961) redescribed the species but many characteristics such as P2, the endopod of P1 and the antennule setation remained unknown. This single species shows the same body shape as *P. uncinatus*, and is similar to *P. sphaericus* (Brady, 1910). In *P. sphaericus* the margins of the third pedigerous somite are parallel to the urosome, and cover the genital somite projections, unlike *P. uncinatus*. Only one minor difference has been observed between the present material and the original description of *P. uncinatus*. The distal seta of the antenna is not as long as described by Eiselt (1961) and Brady (1910). However, this difference is not considered specifically significant.

Acknowledgements

I wish to thank Dr G.C.B. Poore (Museum Victoria) for providing the specimens and the opportunity to study this material; Dr G. A. Boxshall (The Natural History Museum) who kindly offered his opinion about *Pseudotrogus uncinatus*; and Dr D. McKinnon (Australian Institute of Marine Sciences) who provided valuable comments. This study was supported by a grant from the Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP - 98/15333-3).

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Memoirs of the Museum of Victoria 59(2): 457–529 (2002)

NEW PHREATOICIDEA (CRUSTACEA: ISOPODA) FROM GRAMPIANS NATIONAL PARK, WITH REVISIONS OF *SYNAMPHISOPUS* AND *PHREATOICOPSIS*

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Abstract

Wilson, G.D.F. and Keable S.J. 2002. New Phreatoicidea (Crustacea: Isopoda) from Grampians National Park, with revisions of *Synamphisopus* and *Phreatoicopsis*. *Memoirs of Museum Victoria* 59(2): 457–529.

The Grampians National Park, Victoria, has substantial environmental significance owing to the diversity of endemic species restricted to this reserve. We reinforce this observation by reporting six new species and two new genera of isopod crustaceans endemic to the Grampians, and redescribe two previously known Victorian species representing formerly monotypic genera. These isopods are members of the ancient suborder Phreatoicidea, and show diverse morphologies. To demonstrate the basis for the classification of these species, we present a phylogenetic analysis of exemplar species of most extant genera of Phreatoicidea. Our analysis supports the sister group relationship of *Phreatoicopsis* and *Synamphisopus*. We observe a rudimentary accessory flagellum on the antennulae of both genera, but this isopod plesiomorphy optimises on the cladograms as a reversal. Two new genera, *Naiopegia* gen. nov. and *Gariwerdeus* gen. nov., are members of the Phreatoicidae, but are distinct from any described taxa in this family. Various metazoan and protist epibionts are commonly encountered on these isopods. These species are described using detailed scanning electron microscopy and inked drawings: family Amphisopodidae, *Phreatoicopsis raffae* sp. nov., *Phreatoicopsis terricola* Spencer and Hall, 1897, *Synamphisopus doegi* sp. nov., *Synamphisopus ambiguus* (Sheard, 1936); family Phreatoicidae, *Naiopegia xiphagrostis* gen. nov., sp. nov., *Gariwerdeus turretensis* gen. nov., sp. nov., *Gariwerdeus beehivensis* sp. nov. and *Gariwerdeus ingletonensis* sp. nov.

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Introduction

We report six new endemic phreatoicidean isopod crustacean species from The Grampians National Park, in western Victoria, Australia. These isopods are possibly threatened by human use of their ecosystems because The Grampians, despite containing unique landforms, flora and fauna, has a long history of degradation. Anthropogenic impacts include water impoundments, in-stream structures, timber harvesting, grazing and tourism. Although the Park would not ordinarily achieve a high conservation rating owing to this history of human disturbance, it has much natural significance (LCC, 1991; Doeg, 1997). A recent study of invertebrates inhabiting riffle zones of streams in the Grampians (Doeg, 1997) identified at least 20 sites with conservation significance, based on their content of rare or endemic species. Standard limnological methods used in that study collected only relatively large phreatoicidean specimens of the genus *Synamphisopus* Nicholls, 1943 (Doeg, pers. comm.), and are unlikely to collect the smaller groundwater-dependent taxa reported in this paper. Taking account of this groundwater component, the endemic aquatic fauna of the Grampians National Park is more diverse than previously documented.

A phylogenetic analysis combining the Grampians phreatoicidean fauna with representatives of all other extant genera delimits the systematic relationships of these taxa. This analysis justifies the creation of two new genera for the family Phreatoicidae, *Naiopegia* gen. nov. (monotypic) and *Gariwerdeus* gen. nov. (three new species), as well as new species for the Amphisopodidae genera *Synamphisopus* and *Phreatoicopsis* Spencer and Hall, 1897. These taxa contribute to an understanding of the phylogenetic diversity of the Grampians, owing to their ancient derivation (Wilson and Keable, 2001) and apparently long isolation in this region.

Methods. Isopods described in this paper were collected during a 3-day visit to the Grampians National Park during September 1999. In all cases, samples were taken from substrates on the edges of streams or in springs and seeps using small plastic hand sieves (~1 mm mesh), and field sorted into small plastic containers. Specimens were preserved in either sodium bicarbonate neutralised 10% formalin solution or 95% ethanol. Preparation of this material for scanning electron microscopy (SEM) included dissection and isolation of individual limbs, ultrasonic cleaning and CO2 critical point drying. Images were obtained using a Leo 435VP SEM equipped with a Robinson backscatter detector, and then saved as digital TIF files. The images were placed into digital image plates with the background removed. The pleopods, which often become distorted during drying, and holotypes were illustrated using light microscopy. Descriptions were generated using the taxonomic database system DELTA (Dallwitz, 1980; Dallwitz et al., 2000a, b; Wilson and Keable, 1999, 2001, 2002). The diagnoses and descriptions below contain only those characters that are diagnostic or that differ among species of the same genus. Descriptions are based on the male holotype or paratypes; female characters are those features that differ from the male and differ among species in the same genus. In the case of the monotypic new genus *Naiopegia*, we have compared this species with members of *Gariwerdeus* gen. nov. Methods for creating figures and collecting morphological data are described in Wilson and Keable (2002). Phylogenetic analyses used PAUP* (ver.4b8, Swofford, 2001), with the following commands to search for shortest length trees: "hs addseq = random nchuck = 3 chuckscore = 1 nreps = 200 randomize = trees; hs start = current nchuck = 0 chuckscore = 0;". Successive weighting (commands repeated three times: "reweight; hs") was used to assess the topology based on the least homoplastic characters. Table 1 provides the taxonomic data for the species in this analysis; the data and results are reported in supplementary information (see http://www.museum.vic.gov.au/memoirs/index.html). Because internal structures of the major clades are uncertain, we do not discuss the characters and results other than as a background for the classification of the new taxa described below.

Table 1. Taxa used for phylogenetic analysis.

Taxa Outgroups	Source of Data
Spelaeogriphus lepidops (Spelaeogriphacea)	Gordon, 1957
Kalliapseudes obtusifrons (Tanaidacea)	AM P26099
Tainisopus fontinalis (Isopoda)	Wilson and Ponder, 1992
Stenasellus virei (Isopoda Asellota)	Magniez, 1975

Table 1. Continued

Taxa Phreatoicidea	Source of Data
Amphisopus annectans	AM P61300
Amphisopus lintoni	AM P8795
Colubotelson joyneri	AM P8796
Colubotelson searli	AM P54098
Colubotelson sp. 1 (Penstock Lagoon, Tas.)	AM P54096
Colubotelson sp. 2 (Uni. Tas.)	AM P54097
Crenisopus acinifer	Wilson and Keable, 1999
Crenoicus buntiae	Wilson and Ho, 1996
Crenoicus harrisoni	NMV J13924, AM P4076, AM P4081
Crenoicus sp. nov.	AM P61301
Eophreatoicus sp. nov. 4	AM P61302
Eophreatoicus sp. nov. 6	AM P54099
Hyperoedesipus plumosus	WAM 10665/6, AM P8799
Hypsimetopus sp. nov. (near Zeehan, Tas.)	AM P54100
Mesacanthotelson setosus	TMH G634/18979
Mesacanthotelson tasmaniae	AM P8767
Mesamphisopus abbreviatus	TMH G681, TMH G682
Mesamphisopus capensis	TMH G678
Metaphreatoicus australis	AM P3347
Metaphreatoicus lacustris	AM G5502
Metaphreatoicus sp.	AM P52667
Neophreatoicus assimilis	Chilton, 1894
Notamphisopus dunedinensis	USNM 54755, Acc.No. 66824; USNM 99567, Acc.No. 45995
Nichollsia kashiense	Zoological Survey of India C4516/1, C4517/1
Onchotelson brevicaudatus	TMH G3274
Paramphisopus palustris	AM P44487
Paraphreatoicus relictus	TMH G593/18930
Phreatoicoides sp. A	QVM 10: 12377
Phreatoicoides sp. B	QVM 10: 12267
Phreatoicoides gracilis	AM P3348
Phreatoicopsis terricola	this paper
Phreatoicopsis raffae sp. nov.	this paper
Phreatoicus orarii	Nicholls, 1944
Phreatoicus typicus	AM P52733, AM P52734
Phreatomerus latipes	AM P54102
Pilbarophreatoicus sp. 1	AM P54104
Pilbarophreataicus platyarthricus	Knott and Halse, 1999
Synamphisopus ambiguus	this paper
Synamphisopus doegi sp. nov.	this paper
Uramphisopus pearsani	TMH G725
Pelubo paraliotus Wilson and Keable, 2002	WAM C 25051–25052; AM P60532–60533
Eremisopus beei Wilson and Keable, 2002	WAM C 25049–25050, AM P60527–60531
Platypyga subpetrae Wilson and Keable, 2002	WAM C 25053–25054; AM P60537–60539
Naiopegia xiphagrostis gen. nov., sp. nov.	this paper
Gariwerdeus turretensis gen. nov., sp. nov.	this paper
Gariwerdeus beehivensis sp. nov.	this paper
Gariwerdeus ingletonensis sp. nov.	this paper

Abbreviations. NMV, Museum Victoria, Melbourne; AM, Australian Museum, Sydney; QVM, Queen Victoria Museum, Launceston; SAM, South Australian Museum, Adelaide; TMH, Tasmanian Museum and Art Gallery, Hobart; USNM, United States National Museum, Washington, DC; WAM, Western Australian Museum, Perth; bl, body length; GPS, global positioning satellite fix; ind., individuals, specimen or specimens.

Phylogenetic analysis

Parsimony analysis of the data found 84 trees of length 694 (see supplementary information). When subjected to successive weighting, only three trees result from the analysis. Figure 1 shows the strict consensus of both the parsimony and weighted parsimony analyses. The parsimony consensus shows large polytomies for the taxa of the Amphisopodidae, the Western Australia and Indian species of the Hypsimetopodidae and various clade levels within the Phreatoicidae. Polytomies also appear in both consenses within the genera *Mesamphisopus, Crenoicus* and *Gariwerdeus* gen. nov. because the analysis does not include features that are diagnostic at a species level within those taxa. The presence of *Platypyga subpetrae* Wilson and Keable, 2002 appears to cause most of the discordance among

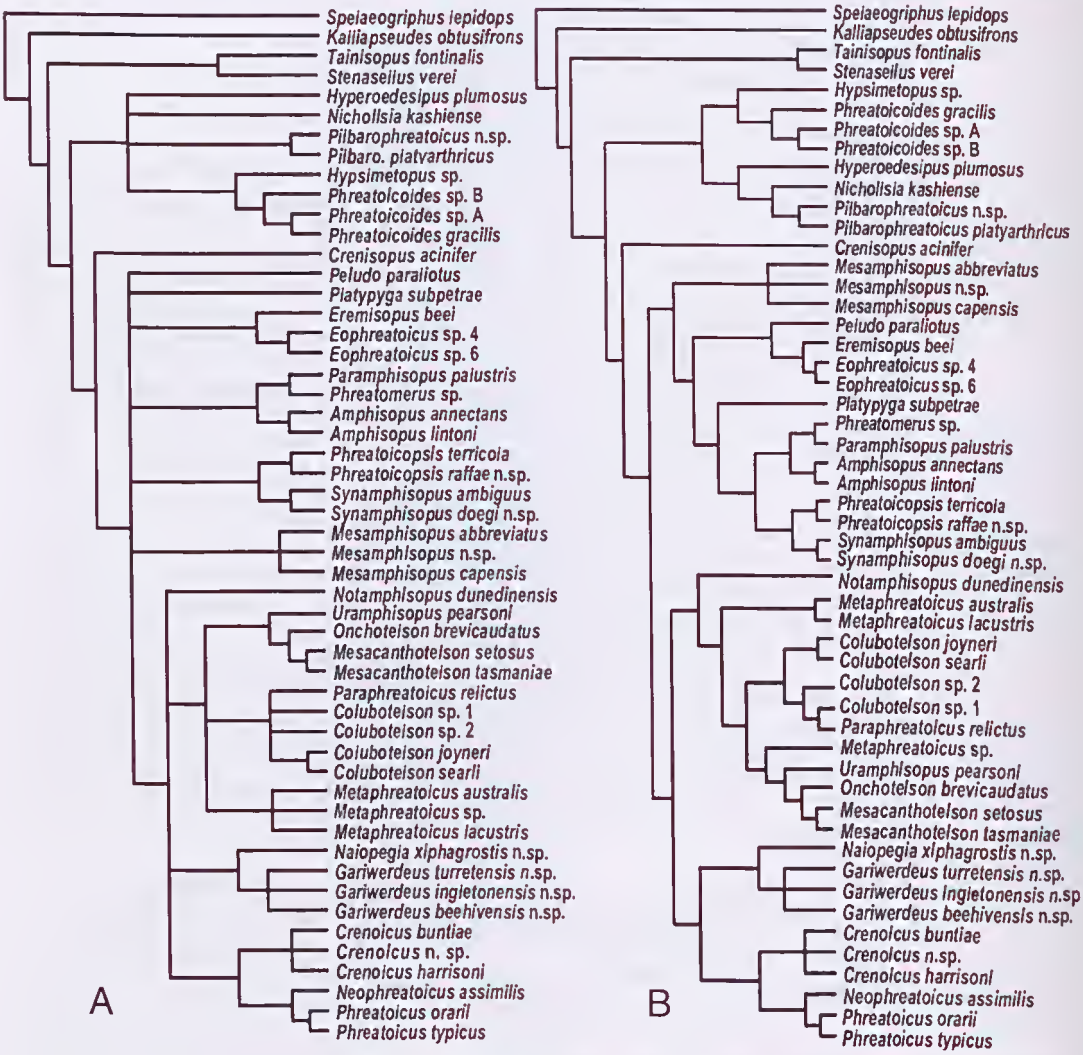

Figure 1. A, strict consensus of parsimony analysis. B, strict consensus of successive weighted parsimony analysis.

equally parsimonious trees. In an Adams consensus of the 84 trees (see supplementary information), *Platypyga* appears in a polytomy with two resolved Amphisopodidae clades, indicating that this species causes the collapse of the amphisopodid clades in the strict consensus tree. Deleting this taxon reduces the tree set from 84 trees to only 9 much more resolved trees (length 679) (see supplementary information). In the trees from all of these analyses (parsimony, weighted parsimony, *Platypyga* removed), general features appear consistently – two major clades corresponding to the families Hypsimetopodidae (sensu Wilson and Keable, 2001) and Phreatoicidae, with *Crenisopus* Wilson and Keable, 1999 emerging on the branch between Amphisopodidae and Hypsimetopodidae. Stable superspecific clades occur within the families:

Hypsimetopus + *Phreatoicoides*;

Amphisopus + *Phreatomerus* + *Paramphisopus*;

Phreatoicopsis + *Synamphisopus*;

Eremisopus + *Eophreatoicus*;

Crenoicus + New Zealand taxa *Phreatoicus* and *Neophreatoicus*;

Gariwerdeus + *Naiopegia*.

The positions of these stable clades vary within the major clades depending on the composition of the analysis; additional species or new characters often change the relationships. For the purposes of this paper, however, these results are stable among all trees. Species of *Gariwerdeus* gen. nov. are monophyletic, with *Naiopegia* gen. nov. as its sister group within the Phreatoicidae. The genera *Phreatoicopsis* and *Synamphisopus* are monophyletic, and together form a monophyletic clade within a less well-defined amphisopodid clade.

This latter result is surprising because *Phreatoicopsis* superficially resembles no other phreatoicidean genus. Nevertheless, Nicholls (1943) originally assigned the genera *Synamphisopus* and *Phreatoicopsis*, with *Eophreatoicus* Nicholls, 1926, *Protamphisopus* Nicholls, 1943 (a Triassic fossil) and *Uramphisopus* Nicholls, 1943 to the heterogeneous amphisopodid subfamily "Phreatoicopsinae" [sic]. The relationships of *P. rotamphisopus* are under study (research in progress), but *Eophreatoicus* is the sister group to *Eremisopus* Wilson and Keable, 2002 (fig. 1A), and clearly not as closely related to *Synamphisopus* and *Phreatoicopsis*. *Uramphisopus* is a member of the Phreatoicidae (Wilson and Keable, 2001). Moreover, analyses of 12S and 16S rDNA by Wetzer et al. (2001) also support the sister group relationship of *Phreatoicopsis* and *Synamphisopus*. Character states shared by the two genera, other than those discussed below (*Phreatoicopsis* remarks), include a large spine on the propodal palm of the male first pereopod, but variation among the species weakens the support of the relationship. The rudimentary second flagellum on the antennula is observed in both genera (*Phreatoicopsis*: figs. 3C, 10F; *Synamphisopus*: 18D), but this isopod plesiomorphy optimises on the cladograms as a reversal supporting the sister relationship of the two genera. Our previous analysis of the Phreatoicidea (e.g., Wilson and Johnson, 1999; Wilson and Keable, 2001) did not find this sister relationship because several synapomorphies of *Synamphisopus* and *Phreatoicopsis* were omitted from the analysis, and one feature (depth of pleonite pleurae) was incorrectly scored. The relative uncertainty of within-family relationships that remain in our analyses prevents the use of Nicholls' (1943, 1944) subfamily categories in the current classification.

Epibionts

Practically all large specimens of *Phreatoicopsis* are found with Temnocephala (Platyhelminthes) crawling on their sternites and ostracodes on their pleopods, as in many Australian crayfish (Parastacidae). All species of *Gariwerdeus* gen. nov., *Naiopegia* gen. nov. and to a lesser extent *Synamphisopus* and *Phreatoicopsis* have substantial populations of protozoan epibionts growing on their limbs and somites. In some body positions, the protist epibiont burden is substantial (e.g., pereopods – fig. 54A, or mouthparts – fig. 44E). Other phreatoicideans have been recorded with various types of sessile protists (Kane, 1969; Clamp, 1991; Fernandez-Leborans and Tato-Porto, 2000; O'Donoghue and Adlard, 2000; Wilson and Keable, 2002). Clamp (pers. comm.) has recorded lagenophryid peritrichs on all phreatoicidean families: *Metaphreatoicus australis* (Chilton, 1891), *Colubotelson searli* Nicholls, 1944, *C. joyneri* (Nicholls, 1926), *C. chiltoni* (Sheppard, 1927), *Mesacanthotelson tasmaniae* (Thomson, 1894), *Phreatoicoides longicollis* Nicholls, 1943, and *Phreatoicopsis terricola* Spencer and Hall, 1897. Some epibionts may have preferences for host attachment sites, as has been observed in the unrelated *Asellus aquaticus* (Cook et al., 1998), and two different genera may occur on different locations on the body. Dome-shaped Lagenophryidae peritrichs are found on the pleopods and others on the legs, while the stalked peritrich *Vorticella* (fig. 43G) and the suctorian ciliates (fig. 49E) appear to prefer the external surfaces of the limbs and body. How these epibionts affect their hosts is unknown.

Systematics

Amphisopodidae Nicholls

Amphisopidae Nicholls, 1943: 25.

Remarks. Our analyses of character distributions among the Phreatoicidea (results above, Wilson and Keable, 2002) has identified an assemblage of taxa that may be assigned to the family Amphisopodidae. The unweighted analyses do not provide strong support for the family, and some taxa do not match the familial characters discussed in Wilson and Keable, 2002. *Platypyga* Wilson and Keable, 2002 is only weakly associated with the Amphisopodidae, although most character weighted analyses of the data find that it belongs to this clade (e.g., successive weighting results outlined above). Therefore, we do not provide a new classification or diagnosis of the Amphisopidae at this time because the status of this family may be questioned. Although eyes frequently are not expressed in phreatoicideans and thus are homoplasious for phylogenetic analyses, all species currently assigned to this family have eyes, if only small spots as in *Phreatoicopsis*. While we do not regard this presumed plesiomorphy as significant, this feature may assist in identification (i.e., blind species probably belong to another family).

Phreatoicopsis Spencer and Hall

Phreatoicopsis Spencer and Hall, 1897: 12.—Sheppard, 1927: 117.—Nicholls, 1943: 112.

Type species. Phreatoicopsis terricola Spencer and Hall, 1897, by monotypy.

Diagnosis. Typhlosole well developed, ventral invagination forming double spiral in cross section. *Pleotelson* posterior margin truncate, circular in posterior view, with terminal anus, not reflexed; lateral lobes absent; dorsal uropodal ridge curving strongly and extending posteriorly from uropods on pleotelson margin. *Antennula* article 3 rudimentary second flagellum present. *Mandible* spine row on round peduncular projection. *Maxillula* lateral lobe distal margin with many (24–25) robust setae, distal setal row separated by gap from other setal rows; inner lobe narrow and tapering, with 3 pappose setae distally. *Pereopod* I daetylus ventral margin proximal tooth present; merus dorsal margin projection spine-like and pointed. *Pereopods* II–VII propodus without articular plate; pereopod IV of male simple, not prehensile; pereopods V–VII basis dorsal ridge not distinctly separated from basis shaft. *Pleopods* protopods I–II lateral epipod linear; pleopod II endopod appendix masculina proximal half of shaft solid and rod-like, indented in ventral cross section, with several large subterminal denticles around lateral to medial and dorsal surfaces. *Uropod* rami distal tips pointed.

Remarks. Phreatoicopsis species, in addition to being among the largest of the phreatoicideans and living in semiterrestrial habitats, have other unusual features. Live animals have a light, sometimes pearly cuticle, with bands or patches of bright yellow on some dorsal surfaces, most obviously the head. The legs of *Phreatoicopsis* are unusually thin, lacking the typical amphisopodidan dorsal margin plates on the pereopodal bases, and the large pleonal pleurae possibly form a respiratory chamber for pleopods. Setae on the body and limbs are few, short and typically robust. The small setae on the margins of the pleopods are minutely plumose. The pleotelson lacks any of the typical embellishments seen in aquatic phreatoicideans; it is smooth, simply constructed and opens posteriorly, with a fringe of setae on the posterior margin. Interestingly, the lateral outline of the *Phreatoicopsis* pleotelson (e.g., figs 2, 9C, 16B) resembles that of *Protamphisopus*, which Nicholls (1943) placed in his rather heterogeneous subfamily Phreatoicopsinae. Hermaphroditism may be an important feature of the *Phreatoicopsis* reproductive system, although the reasons for the apparently varying proportions of intersexes remain to be determined.

As discussed above, *Phreatoicopsis* is the sister group to *Synamphisopus*. This relationship is based on the following putative synapomorphies: the highly developed typhlosole in the hindgut; an unusually high number of robust setae on the maxillula lateral lobes (*Phreatoicopsis* – fig. 5B; *Synamphisopus* – figs 20B–C); blunt denticles on the distal tip of the appendix masculina (*Phreatoicopsis* – fig. 16D; *Synamphisopus* – figs 23C–E, 31I–J); and a peduneulate mandibular spine row (*Phreatoicopsis* – figs 4D–E, H, J; *Synamphisopus* – figs 19B, H, J). The spine row structure is distinct from that of the Phreatoicidae because the bifurcate spines are fused basally so that the two rami of each spine appear to be independent, giving an open appearance to the centre of the spine row. The spine row of *Synamphisopus* is somewhat less modified than in *Phreatoicopsis* and flattened dorsoventrally, appearing more similar to the typical spine row of other amphisopodids.

Phreatoicopsis specimens from the Grampians were previously identified as *P. terricola* Spencer

and Hall (first noted by Raff, 1912). Our examination of this morphologically conservative genus indicates that populations from the Grampians represent a new species, as suggested by Nicholls (1943).

Phreatoicopsis raffae sp. nov.

Figures 2–9

Phreatoicopsis terricola.—Raff, 1912: 70, pl. 5.—Nicholls, 1943: 113, figs 27, 28 (part, material from vicinity of the Grampians is not *Phreatoicopsis terricola* Spencer and Hall, 1897).

Material examined. Holotype. Victoria (Vic.), Flatrock Crossing, Glenelg River Road, Grampians National Park, 37°09.77′S 142°26.59′E (GPS), soil among roots of ferns and under sphagnum moss on side of seep, collected by hand and spoon, R. Wetzer, S. Keable and G. Wilson, 20 Sep 1999, VIC-87, NMV J40730 (male bl 51.9 mm, ethanol preserved).

Paratypes. All lots collection details as for holotype. AM P61250 (1 male bl 32.5 mm, 2 females bl 45.7/51.4 mm, 1 juvenile female bl 29.1 mm, 1 hermaphrodite (with penes, no appendix masculina, with oostegite buds) bl 32.7 mm, 1 indeterminate juvenile bl 19.6 mm), AM P61436 (1 male bl 40.7 mm, dissected for illustration, description and SEM), AM P61437 (1 female bl 46.8 mm, dissected for description and SEM).

Other material. Vic., The Grampians, no other data, AM P61251 (9 ind. ex NMV). Vic., The Grampians: N of the Divide (37°17′S, 142°33′E), 21 Dec 1934, NMV J44871 (>30); Vic., S of the Divide (37°17′S, 142°33′E), I. Mitchell (Stawell, Vic.) per A. Chisolm, 25 Dec 1934, NMV J44873 (>30); Vic., Bellfields, 37°17′S, 142°33′E, J. Clark, 14 Aug 1935, NMV J44882 (5); Vic., Swamp at head of Wannon R. (37°19′S, 142°31′E), J. Clark, 14 Aug 1935, NMV J44892 (7); Vic., Swamp at head of Wannon R. (37°19′S, 142°31′E), J. Dawson, 04 Sep 1935, NMV J44893 (9); Vic., N. McCance, Jul 1961, NMV J21805 (1); Vic., Glenelg R. (37°11′S, 141°43′E), A. Neboiss, 16 Dec 1966, NMV J44885 (1); Vic., 37°17′S, 142°33′E, R. Veerman, December 1968, NMV J44898 (1); Vic., Mt William (37°13′S, 144°48′E), C. McCubbin, 28 Apr 1971, NMV J44883 (1); Vic., Glenisla Range (37°14′S, 142°11′E), A. A. Calder, 04 Mar 1976, NMV J44896 (3) and NMV J44895 (2); Vic., Mt William, 100 m S. of summit, 27 Aug 1978, M.S. Harvey, NMV J48353 (1 female); Vic., Jimmys Creek, 25 Aug 1983, J. Baldwin, NMV J48354 (2); Vic., near Jimmys Creek and Dunkeld Road (37°22′S, 142°31′E), R. Duggan, 26 Jan 1987, NMV J44868 (5); Vic., 37°17′S, 142°33′E, H. Clark, NMV J44869 (57).

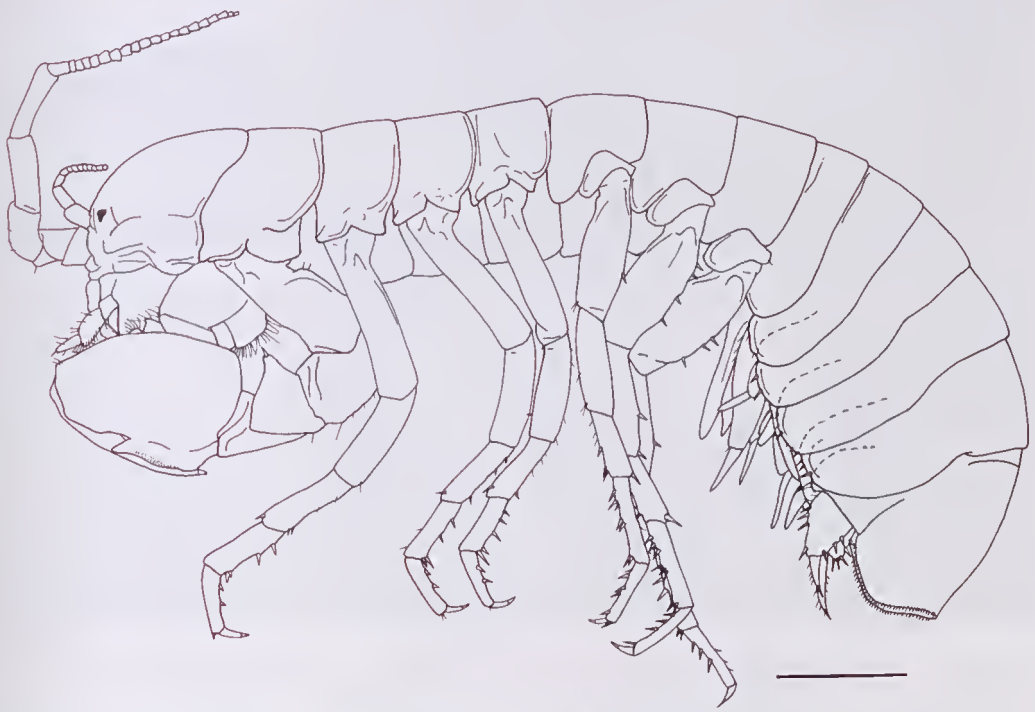

Figure 2. *Phreatoicopsis raffae*, sp. nov. Holotype (NMV J40730), lateral view. Scale bar 5 mm.

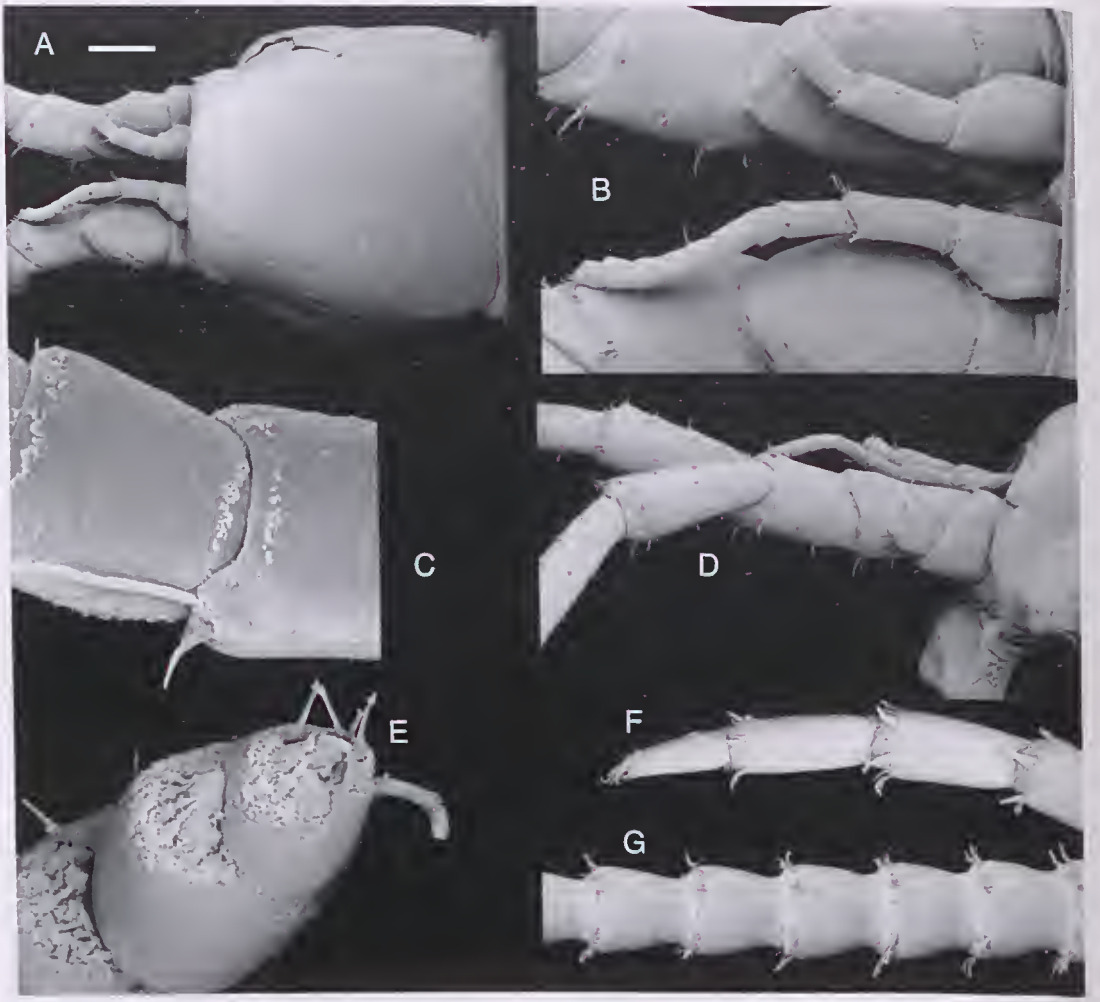

Figure 3. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436). A, head, dorsal view. B, antennula, antenna proximal artieles, dorsal view. C, antennula article 3 rudimentary second flagellum. D, head, lateral view with antennula and antenna proximal artieles. E, antennula, distal tip. F–G, antenna flagellum, distal and proximal articles. Seale bar 1 mm.

Vic., (Vial label gives locality as "From Groener, West Australia", A second label in the vial says "The locality of these speeimens is doubtful! Probably Western Victoria") I.R. McCann, 9 November 1982, NMV J44890 (19). No label data: J44782 (2), J44888 (3)

Etymology. This species is named after Janet W. Raff, who first recorded it from the Grampians (Raff, 1912).

Diagnosis. *Pleotelson* length subequal to width in dorsal view, dorsal length 0.96 width. *Left mandible* incisor process dorsal margin with fourth sloping cusp. *Maxillula* lateral lobe with 4 robust setae in distal row. *Pereopod* VII basis dorsal ridge with robust setae. *Uropod* protopod dorsomedial ridge not projecting beyond distal margin, linear.

Description, including all adult forms. *Coloration* in life head with large patch of yellow, posterior margins of pereonites 6–7, pleonites 1–2 or 2–3 with yellow transverse stripe, body otherwise grayish, white pereopods, tiny black eye; in 95% ethanol uniform cream, eye black.

Head (figs 3A, D) width 0.73 pereonite 1 width. Eyes maximum diameter 0.12 head depth.

Pleonites (fig. 2) 1–4 width 0.78 composite length in dorsal view.

Figure 4. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436). A, paragnaths. B–G, left mandible. H–J, right mandible. Scale bar 0.5 mm.

Figure 5. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436). A–C, maxillula. D–E, maxilla. F–G, maxilliped. Scale bar 1 mm.

Pleotelson (figs 9A, C) lateral length 0.14 body length; depth 1.95 pereonite 7 depth; posterior margin with 72 setae (approximately, including anterior ventral margin near insertion of uropod); ventral margin anterior to uropods with 6 setae.

Antennula (figs 3B–C) length 0.07–0.1 body length, with 13–14 articles. Article 5 length 1.5 width. Article 6 length 1.2 width. Several tiny aesthetases on article 11 to terminal article. Terminal article length 0.8 width. *Antenna* (figs 2, 3F–G) length 0.38 body length. Flagellum length 0.43–0.62 total antenna length, with 18–22 articles.

Mouthfield clypeus width 0.52 head width. *Mandible* (figs 4B–J) palp length 1.12 mandible length; article 3 with 7 setae, setae dentieulate (minutely). Left spine row with 17 spines (basally fused, therefore total probably representing count of both sides of approximately 8 bifureate spines), additional spines between pedunculate projection and molar absent. Molar process length subequal to width; fine simple spines forming posterior row (short). *Maxillula* (figs 5A–C) medial lobe width 0.5 lateral lobe width; with 8 'accessory setae'. Lateral lobe distal margin with 24 smooth robust setae.

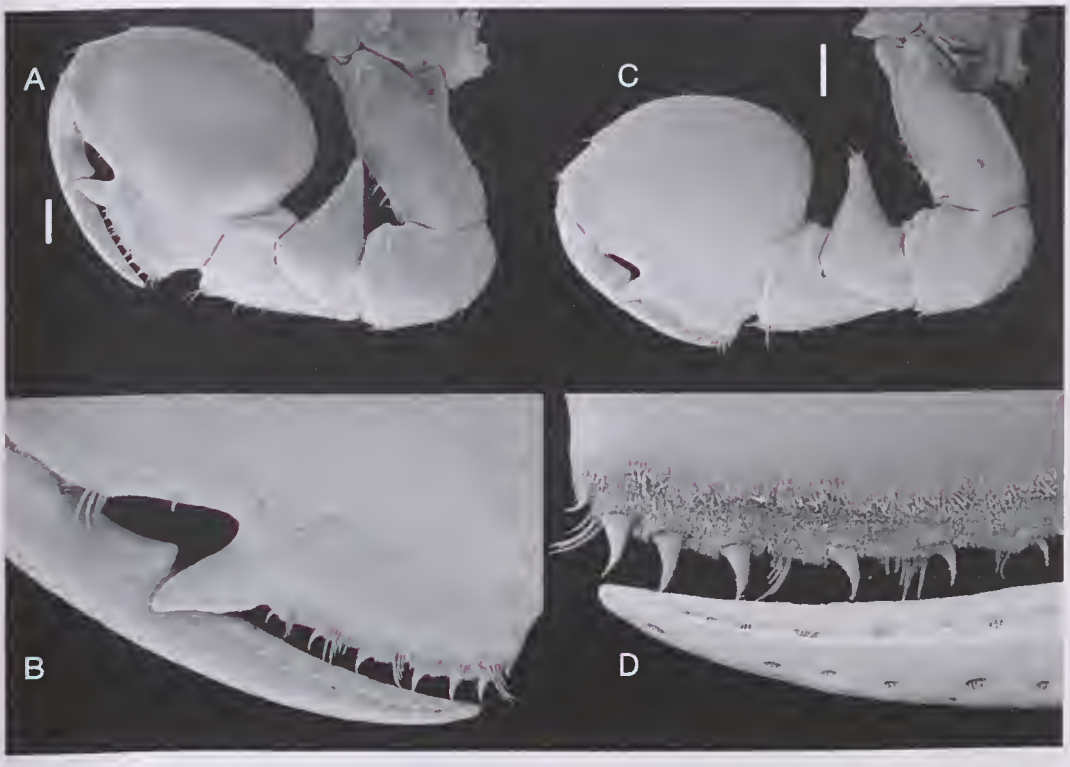

Figure 6. *Phreatoicopsis raffae*, sp. nov. Paratype female (AM P61437), paratype male (AM P61436). A–B, female pereopod I. C–D, male pereopod I. Scale bar 1 mm.

Maxilla (figs 5D–E) medial lobe width 1.33 outer lateral lobe width. Outer lateral lobe length subequal to inner lateral lobe (ratio 1.02). *Maxilliped* (figs 5F–G) endite distal tip with approximately 20 subdistal biserrate setae on ventral surface; medial margin with 6 coupling hooks on left side; dorsal ridge with 17 large distally not noticeably denticulate plumose setae. Palp article 4 length 0.73 width; article 5 length 1.75 width, length 0.75 article 4 length.

Pereopod I (fig. 6) dactylus length subequal to palm length. Propodus length 0.88 width; dorsal margin with 8 minute setae (excluding distal group). Propodal palm with 6–8 broad based setae. Basis length 2.0 width, dorsal ridge with approximately 13 minute setae scattered along ridge. *Pereopod* IV (figs 7A–B) length 0.38 body length. Propodus length 4.5 width, with 4 broad based setae on ventral margin (5 submarginally). Carpus length 0.16 pereopod length, with 4 broad based setae on ventral margin in male (7 submarginally, 1 distinctly larger than others). Ischium posterodistal margin with 4 setae in male (8 submarginally). Basis length 3.25 width.

Penes length 0.37 body width at pereonite 7.

Pleopod (fig. 8) I endopod length 0.65 exopod length. *Pleopod* II endopod length 0.65 exopod length. *Pleopod* III exopod distal article length 0.32 exopod length; endopod length 2.04 width, 0.68 exopod length. *Pleopod* IV exopod length of distal article 0.33 exopod length; endopod length 1.75 width. *Pleopod* V endopod length 1.72 width. *Pleopods* protopod I with 16 simple and minutely serrate setae along length of lateral margin; protopod II with 8 simple and minutely serrate setae along length of lateral margin, 2 submarginally. *Pleopod* I exopod medial margin convex – divergent from lateral margin (weakly concave proximally). *Pleopod* II endopod appendix masculina with 8 minute setae on margin.

Uropod (figs 9B, D, E–G) total length 0.72 pleotelson length. Protopod length 1.89 width, 0.31–0.44 uropod total length; dorsomedial ridge length 0.84 endopod length. Endopod with 3–5 robust setae. Exopod length 0.62–0.67 endopod length, with 3 setae.

Distribution. Central and southern parts of The Grampians National Park, in wetlands or swamps associated with the Wannon and Glenelg Rivers, Victoria.

Remarks. The male and female character states do not appear to be correlated with body size possibly owing to hermaphroditism in this species, so we have not distinguished the sexes in the above

Figure 7. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436), paratype female (AM P61437). A, male pereopod IV. B, female pereopod IV. C, male pereopod VII. D, male pleopod II appendix masculina. E, male pereopod VII proximal articles, with penes. Scale bar 1 mm.

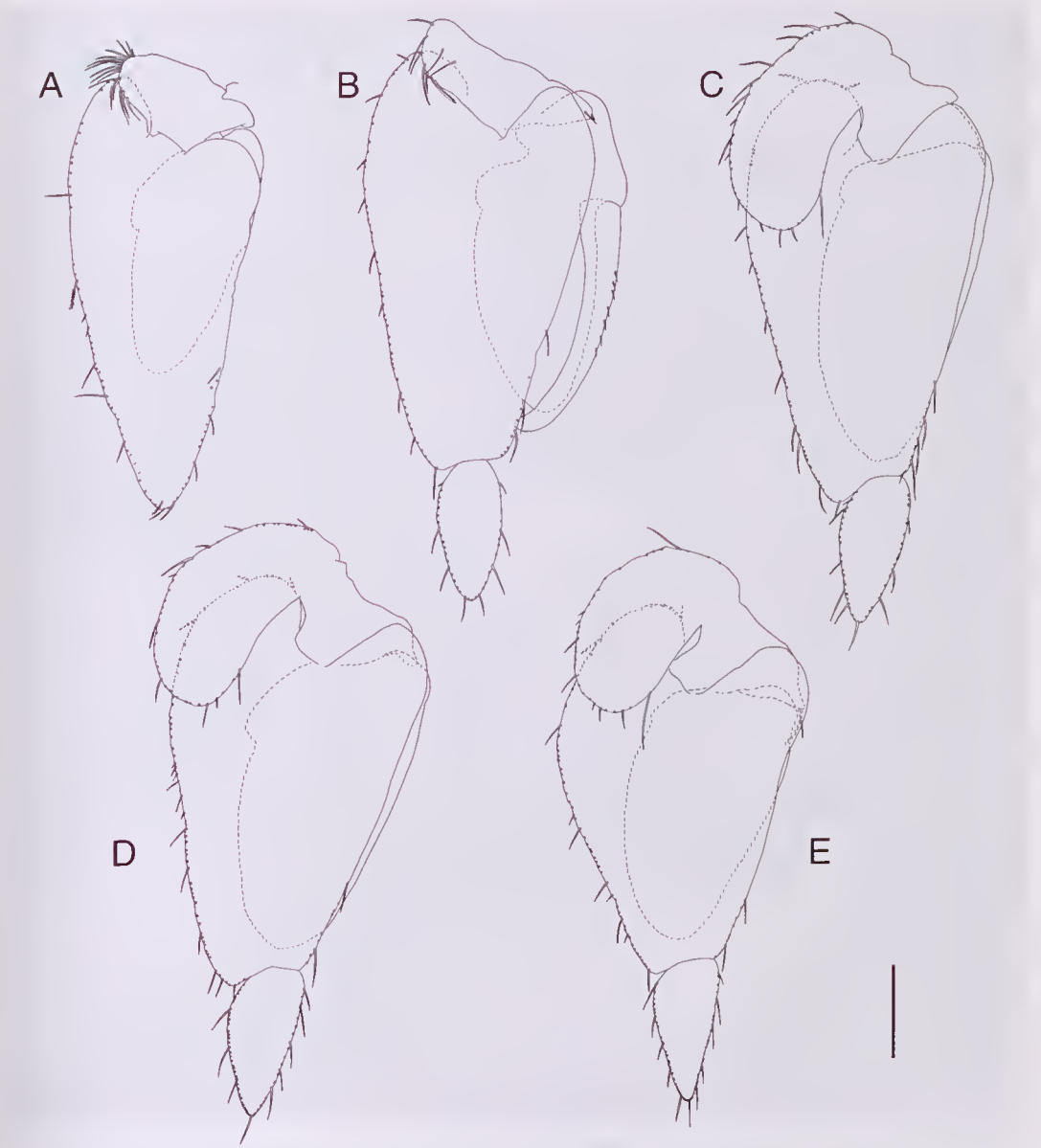

Figure 8. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436). A–E, pleopods I–V. Setae on margins are minutely plumose. Scale bar 1 mm.

description. Species of *Phreatoicopsis* can be identified using the shape of the uropod protopod dorsomedial margin: straight or only slightly curving dorsally and not projecting beyond insertions of rami (*P. raffae*, figs 9D, G) versus curving dorsally and projecting beyond insertions of rami (*P. terricola*, figs 16C, F). Robust setae on dorsal margin on the basis of pereopod VII in *Phreatoicopsis raffae* sp. nov. (fig.7C) as opposed to fine setae in *P. terricola* will distinguish adults of the two species, but this feature may not be useful for specimens of 35 mm or less.

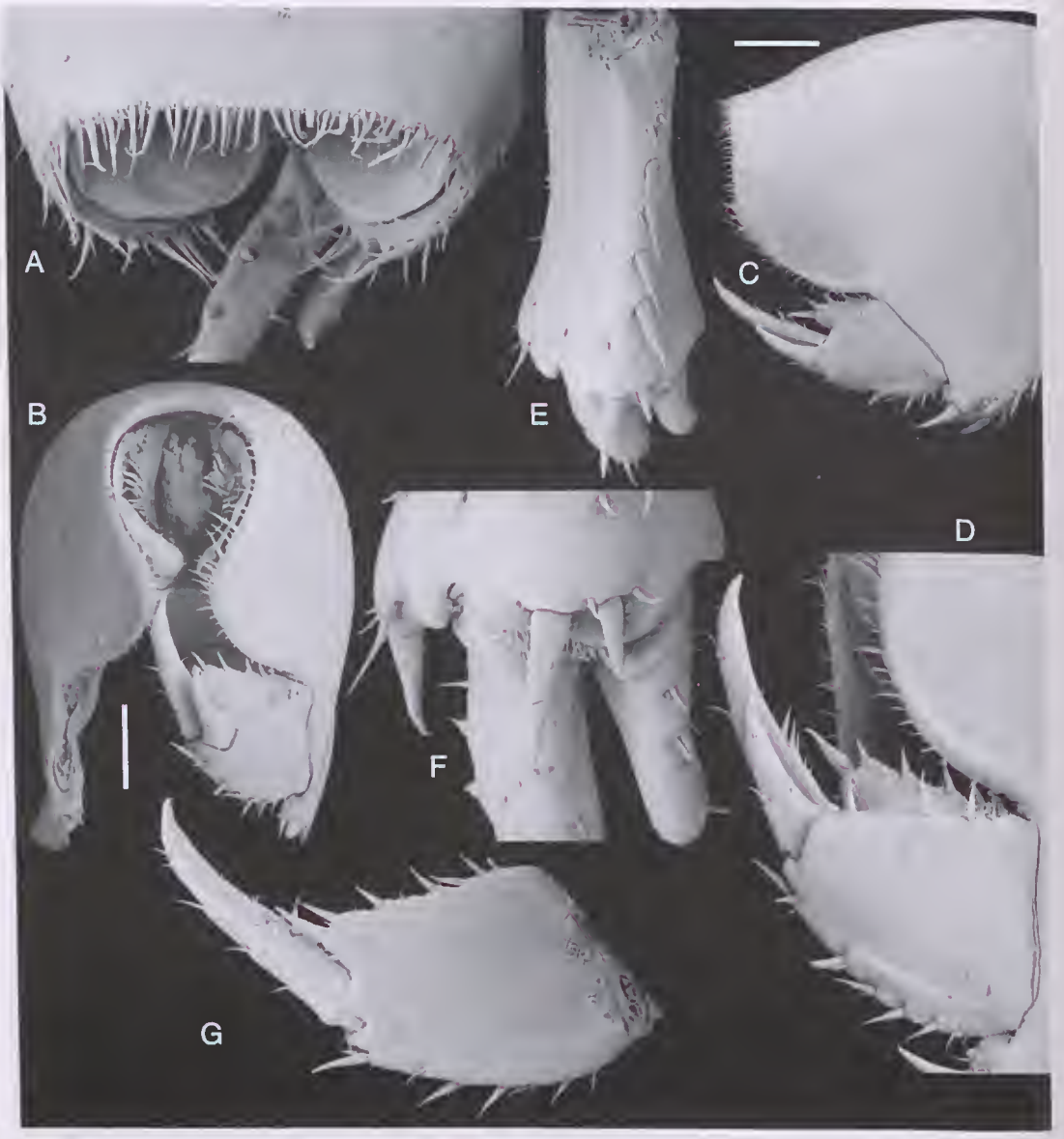

Figure 9. *Phreatoicopsis raffae*, sp. nov. Paratype male (AM P61436). A–D, pleotelson and uropod, dorsal, posterior and lateral views. E–G, uropod ventral and medial views. Scale bar 1 mm.

Phreatoicopsis terricola Spencer and Hall

Figures 10–16

Phreatoicopsis terricola Spencer and Hall, 1897: 12, pls. 3–4.—Raff, 1912: 70, pl.5 (part, material from vicinity of Otway Range).—Nicholls, 1924: 98.—Nicholls, 1926: 203.—Sheppard, 1927: 117.—Barnard, 1927: 160.—Nicholls, 1943: 113, figs 27, 28 (part, material from vicinity of Otway Range).

Not *Phreatoicopsis terricola*.—Raff, J.W., 1912: 70, pl.5.—Nicholls, 1943: 113, figs 27, 28 (part, material from vicinity of The Grampians is *Phreatoicopsis raffae* sp. nov.).

Type material. Probable syntypes. Victoria, "Banks of Upper Gellibrand River, in burrows (W.H.F. Hill)" (Spencer and Hall, 1897: 13), 38°33′S 143°39′E (estimated from map), specimens lost. Nicholls (1943) reported examining specimens from "Museums of

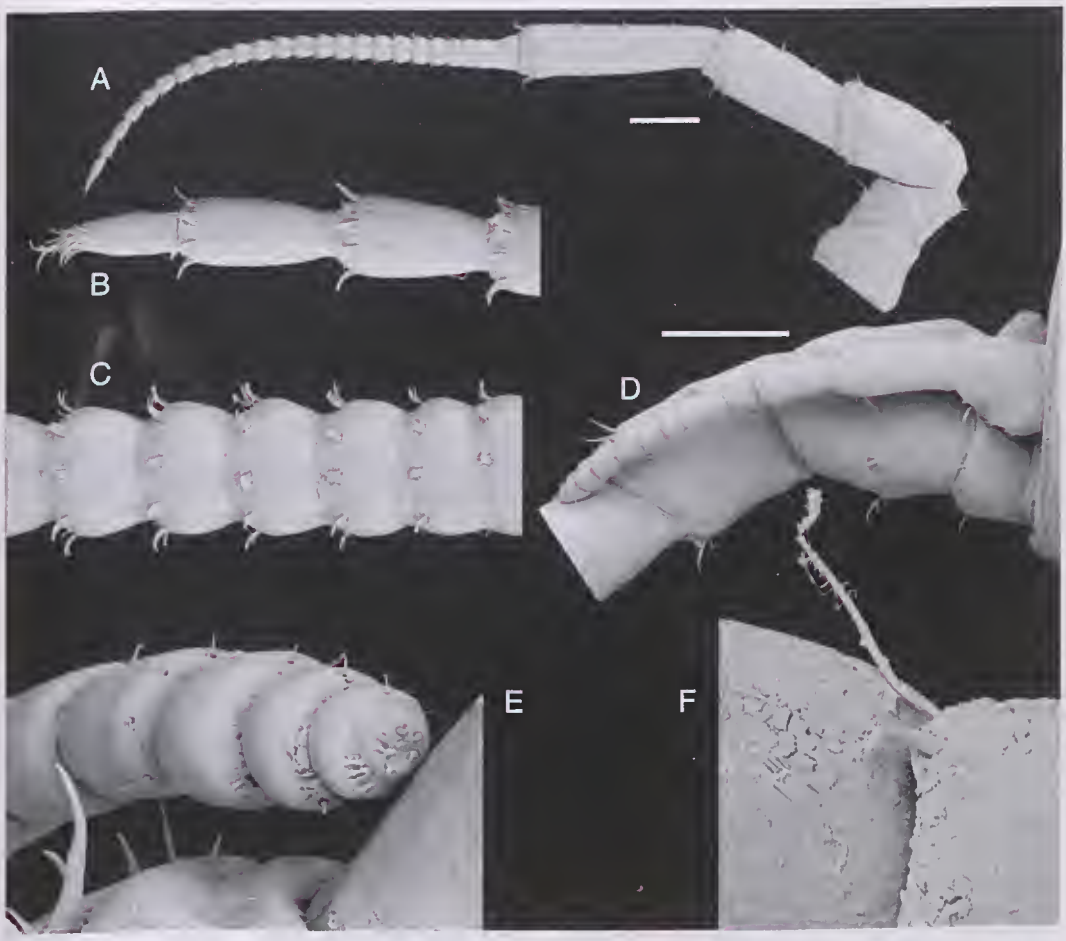

Figure 10. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438). A, antenna. B–C, antenna flagellum, distal and proximal articles. D, antennula, antenna proximal articles, dorsal view. E, antennula distal articles. F, antennula article 3 rudimentary second flagellum. Scale bar 1 mm.

Melbourne and Adelaide" but apparent types have not been found. Museum Victoria (G. Poore, pers. comm.) has specimens of *P. raffae* sp. nov. (see above), that account for some but not all specimens reported by Nicholls.

Material examined. Vic., Otway Range, 200 m west of Benwerrin–Mount Sabine Track, 0.5 km N of Delaney Road, 38°31.90′S 143°50.76′E (GPS), from soil 20cm deep under fern tree root mat in bank of stream, shovel and hand, G. Wilson, R. Wetzer and S. Keable, 25 Sep 1999, preserved in 95% ethanol, VIC-101, AM P61252 (4 hermaphrodites bl 26 (no appendix masculina, pene bud only on one side)/26 (with appendix masculina)/30.5 (no appendix masculina)/40.5 (no appendix masculina) mm, 4 females bl 24.2/29.8/30.2/50.9 mm, 1 juvenile female bl 24.7 mm), AM P61438 (hermaphrodite bl 46.6 mm, dissected for illustration, description and SEM, collection details as for P61252), AM P61439 (hermaphrodite bl 50.2 mm partially dissected for description and SEM, collection details as for P61252); Vic., Otway Range, from 900 m SW of Cowley Track, 38°33.36′S, 143°50.48′E (map), dug from oval burrows in damp sediment under tree fern roots, no free water observed in substrate, W.F. Ponder and G.D.F. Wilson, 15 Jul 1991, Stn V19, AM P54101 (4 juveniles possibly males (pene buds but no appendix masculina) bl 16.6/18.2/25/25.9 mm, 9 males bl 21.1 (penes and appendix masculina not fully developed)/25.5/25.7/27.5/28.2/28.6/35.7/41.2 (dissected for description)/53.8 mm, 1 hermaphrodite (small penes, no appendix masculina, oostegite buds on anterior pereopods) bl 25 mm, 2 hermaphrodites bl 36 (dissected for description)/46.6 (no appendix masculina) mm); Vic., near Lavers Hill, Otway Range, 38°41′S 143°24′E (estimate), pit trap, A. Fraser, 10 Feb 1972,

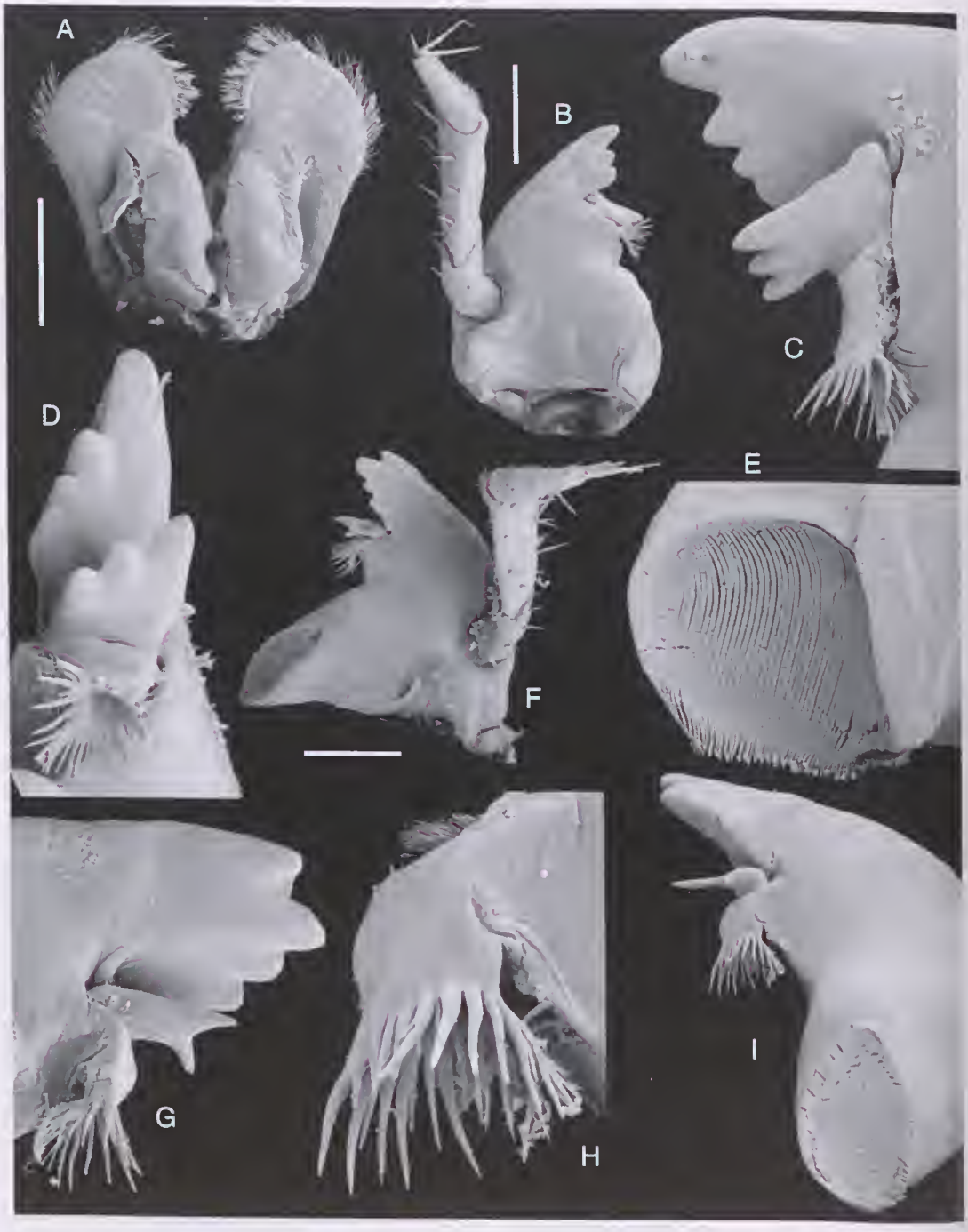

Figure 11. *Phreatoicopsis terricola*. Hermaphrodite (AM P61439) A–B, G–I, hermaphrodite (AM P61438) C–F. A, paragnaths. B, left mandible. C–E, left mandible. F, right mandible. G–I, right mandible. Scale bar 1 mm.

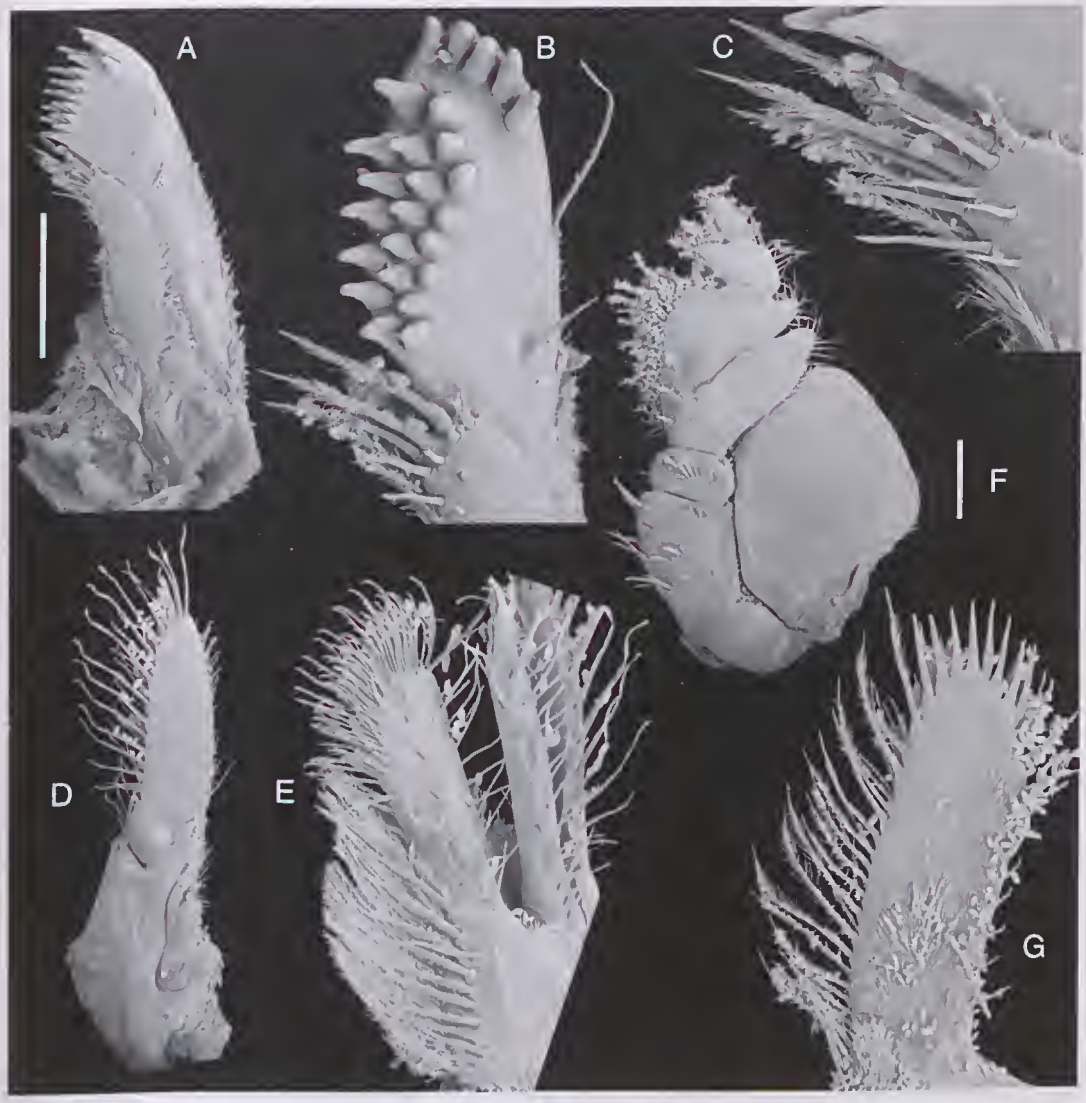

Figure 12. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438) A–E, hermaphrodite (AM P61439) F–G. A–C, maxillula. D–E, maxilla. F–G, maxilliped. Scale bar 1 mm.

AM P31004 (1 ind.); Vic., Forrest (38°31′S, 143°43′E), Davey, HW, 26 Feb 1925, NMV J44880 (1); Vic., Upper Gellibrand Gorge, near Forrest (38°33′S, 143°39′E), 'CWB', 17 Dec 1946, NMV J44894 (8); Vic., Otway, Beech Forest (38°27′S, 143°58′E), W.H.F. Hill, 14 Sep 1897, NMV J44875 (4); Vic., Cape Otway, Beech Forest (38°52′S, 143°31′E), H.P. Ashworth, Apr 1897, NMV J44877 (3 degraded, possibly dried at one time); Vic., Beech Forest (this record included "Grampians" in place name) W.H.F. Hill (collector of the syntypes), 11 Nov 1897, J44884 (16 - tanned colour); Beech Forest NMV J44876 (1); Vic., Otway Ranges, G. Milledge, 11 Apr–14 Jun 1995: Phillips Track 0.5 km N of Triplet Falls (38°40′S 143°29′E), pitfall traps, G. Milledge, *Nothofagus cunninghamii* forest, J48355, (32); Vic., Young Creek Rd 0.4 km NW of Triplet Falls, (38°40′S 143°29′E), pitfall traps, *Eucalyptus* sp. forest, J48356 (6); Vic., Cobden (38°20′S, 143°04′E), N. McCance, Sep 1963, NMV J44886 (1); Vic., Apollo Bay (38°46′S, 143°40′E), Field Naturalists Club of Victoria, Dec 1904, NMV J44874 (28); Vic., Maits Rest, 10 km W of Apollo Bay, Otway Ranges (38°45′S, 143°34′E), in *Nothofagus cunnighamii* forest, Pitfall Trap, G. Milledge, P. Lillywhite and C. McPhee, 30 Oct 1991, NMV J44881 (2). No collection locality data: NMV J44878 (1), NMV J44879 (1), NMV J44848 (1 damaged specimen).

P. terricola variant (see Remarks). Vic., Upper

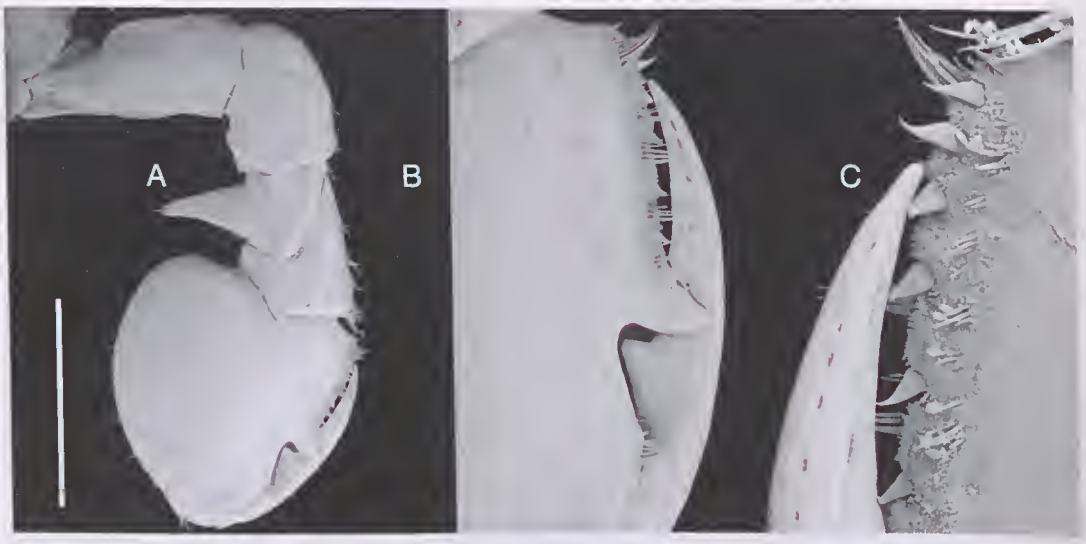

Figure 13. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438). A–C, pereopod I. Scale bar 5 mm.

Gellibrand Gorge, near Forrest (38°33′S, 143°39′E), 'CWB', 17 Dec 1941, NMV J44891 (22, largest is ~30 mm); Vic., Forrest (38°31′S, 143°43′E), Wilhelms, Jul 1948, NMV J44887 (10, largest is ~40 mm).

Diagnosis. Pleotelson length greater than width in dorsal view, dorsal length 1.22 width. *Left mandible* incisor process dorsal margin lacking fourth sloping cusp. *Maxillula* lateral lobe with 5 robust setae in distal row. *Pereopod* VII basis dorsal ridge lacking robust setae. *Uropod* protopod dorsomedial ridge distinctly projecting posteriorly beyond distal margin, concave.

Description based on hermaphrodite. Coloration in life, head with patch of yellow, posterior margins of pereonites 6–7, pleonites 1–3 with yellow transverse stripes, body otherwise grayish, white pereopods, tiny black eye; in 95% ethanol uniform cream, eye black.

Head width 0.82 pereonite 1 width. Eyes maximum diameter 0.09 head depth.

Pleonites 1–4 width 0.60 composite length in dorsal view.

Pleotelson (figs 16A–C, F) lateral length 0.11 body length; depth 1.88 pereonite 7 depth; posterior margin with 66 setae (approximately, including anterior ventral margin near insertion of uropod); ventral margin anterior to uropods with 10 setae.

Antennula (figs 10D–E, F) length 0.10–0.14 body length, with 12–13 articles. Article 5 length 1.2 width. Article 6 length 1.0 width. Several tiny aesthetases on article 9 to terminal article. Terminal article length 0.55 width. *Antenna* (figs 10 A–C) length 0.3 body length. Flagellum length 0.43–0.46 total antenna length, with 24–26 articles.

Mouthfield clypeus width 0.48 head width. *Mandible* (fig. 11) palp length 1.06 mandible length; article 3 with 8 setae, setae smooth. Left spine row with 21 spines (basally fused, total probably representing count on both sides of approximately 10 bifurcate spines), total count including 1 spine on margin between peduncular projection and molar. Molar process longer than wide; spines absent. *Maxillula* (figs 12A–C) medial lobe width 0.39 lateral lobe width; with 7 'accessory setae'. Lateral lobe distal margin with 25 smooth robust setae. *Maxilla* (figs 12D–E) medial lobe width 1.64 outer lateral lobe width. Outer lateral lobe longer than inner lateral lobe. *Maxilliped* (figs 12F–G) endite distal tip with 38 subdistal biserrate setae on ventral surface (approximately); medial margin with 7 coupling hooks on left side; dorsal ridge with 26 large distally denticulate plumose setae (approximately, not noticeably dentieulate). Palp article 4 length 0.66 width; article 5 length 1.67 width, 1.0 article 4 length.

Pereopod I (fig. 13) dactylus length 0.9 palm length. Propodus length 0.97 width; dorsal margin with 12 setae (excluding minute distal group). Propodal palm with 7–8 broad based setae. Basis length 1.86 width, dorsal ridge with 3 minute setae proximally. *Pereopod* IV (figs 14C–D) length 0.31 body length. Propodus length 3.0 width, with 8 broad based setae on ventral margin. Carpus length 0.13 pereopod length, with 8 broad based setae on ventral margin, 2 distinctly larger than others. Ischium posterodistal margin with 7 setae. Basis length 3.83 width.

Penes (fig. 14F) length 0.17 body width at pereonite 7.

Pleopods (figs 15, 16d–E) I endopod length 0.79 exopod length. *Pleopod* II endopod length 0.7 exopod length. *Pleopod* III exopod length of distal article 0.28 exopod length; endopod length 2.21 width, 0.58 exopod length. *Pleopod* IV exopod length of distal article 0.29 exopod length; endopod length 1.97 width. *Pleopod* V endopod length 1.48 width. *Pleopod* protopods I with 10 simple and minutely serrate setae along length of lateral margin; protopod II with 18 simple and minutely

Figure 14. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438) A–B, F, hermaphrodite (AM P61439) C–E. A–B, pereopod II. C–D, pereopod IV. E–F, pereopod VII with penes, including proximal artieles, some setae missing from basis dorsal margin. Scale bar 1 mm.

Figure 15. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438). A–E, pleopods I–V. Setae on margins are minutely plumose. Scale bar 2 mm.

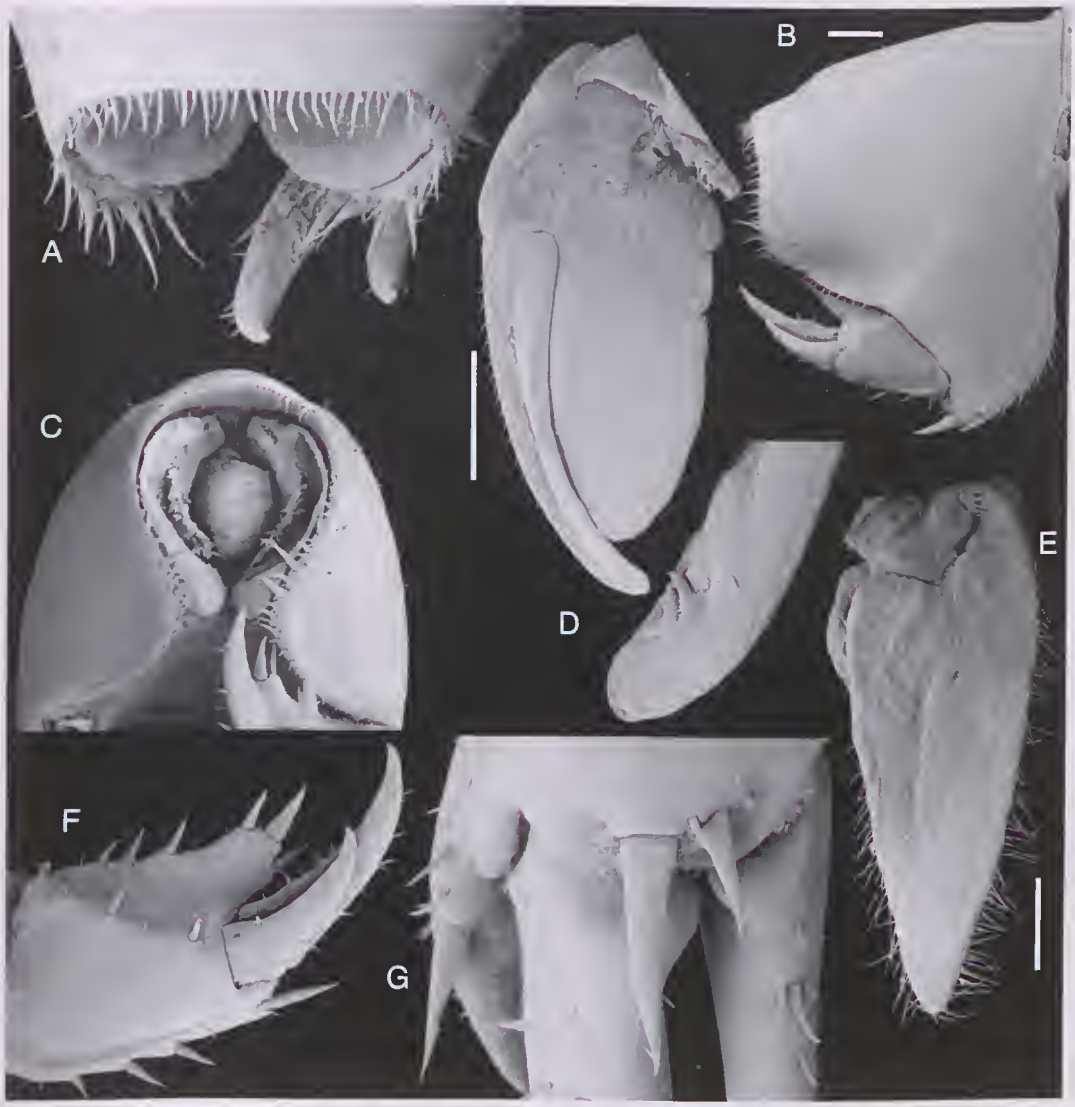

Figure 16. *Phreatoicopsis terricola*. Hermaphrodite (AM P61438). A–C, F, pleotelson and uropod, dorsal, lateral and posterior views. D, pleopod II appendix masculina and endopod. E, pleopod I. G, uropod protopod distal margin, ventral view. Scale bar 1 mm.

serrate setae along length of lateral margin, 1 submarginally. *Pleopod* I exopod medial margin straight – divergent from lateral margin only proximally. *Pleopod* II endopod appendix masculina with 16 setae on margin.

Uropod (figs 16A–C, F–G) total length 0.64 pleotelson length. Protopod length 2.57 width, 0.46–0.5 uropod total length; dorsomedial ridge length 1.15 endopod length. Endopod with 4–6 robust setae (including 3 small dorsolateral setae). Exopod length 0.62–0.78 endopod length; distoventral margin with 2 robust setae.

Distribution. Wetlands of the Otway Range, including Gellibrand Gorge and Cobden, Victoria.

Remarks. See Remarks under *P. raffae* sp. nov. for distinguishing the two known species of this genus. Nicholls (1943) remarked upon the apparent hermaphroditism observed in this species. In the material that we examined, the distribution of male and female characteristics does not appear to be correlated with body size.

Smaller specimens show some differences from adults that might cause difficulty in identification. In particular, the dorsomedial ridge of the uropodal protopod of small specimens does not project significantly beyond the distal margin of the protopod, and may lack the ventral-most of the three setae on the projection (figs 16F,G). These smaller specimens, however, retain the concave margin of the dorsomedial ridge. The pleotelson ventral margin typically has two robust setae anterior to the uropodal insertion, but smaller specimens may only have a single large seta. Two lots of specimens (NMV J44891, J44887) retain these features in larger individuals (up to 4cm); these have been listed separately as variants of *P. terricola*.

Synamphisopus Nicholls

Synamphisopus Nicholls, 1943: 95.

Type species. *Amphisopus ambiguus* Sheard, 1936 by original designation.

Diagnosis. *Typhlosole* well developed, ventral invagination forming double spiral in cross section. *Pleotelson* posterior margin cleft, reflexed dorsally; lateral lobes forming vertical plates; dorsal uropodal ridge curving strongly and extending posteriorly from uropods on pleotelson. *Antennula* article 3 rudimentary second flagellum present. *Mandible* spine row on round peduncular projection. *Maxillula* lateral lobe distal margin with 20–29 smooth robust setae, inner lobe narrow and tapering. *Pereopod* 1 daetylus dorsal margin with dense group of elongate setae. *Pereopods* propodus II–IV without articular plate, V–VII with articular plate; pereopod IV sexually dimorphic, prehensile in male. *Pleopods* II endopod appendix masculina proximal half of shaft broadly concave in ventral cross section, forming tube at distal tip; with large subterminal denticles around lateral to medial and dorsal surfaces. *Uropodal* rami distal tips rounded.

Remarks. The synapomorphies of the clade *Phreatoicopsis* + *Synamphisopus* are discussed above in the *Phreatoicopsis* generic remarks. Features of *Synamphisopus* species that differ from *Phreatoicopsis* include limited sexual dimorphism in the fourth pereopod, rounded tips of the uropods, small dorsal plates of the basis on the posterior three pereopods and shape of the pleotelson. Our phylogenetic analysis identifies these features as plesiomorphic character states within the Amphisopodidae. The dense group of elongate setae on the medial side of the pereopod 1 daetylus, however, are unique to species of *Synamphisopus*. These setae (fig. 21H) are bipinnate with two rows of tiny curved, equal length spinules on the distal third of the setal shaft.

Although *Synamphisopus ambiguus* is a large species, easily found and examined, it has not been studied in detail since Sheard's (1936) original description and Nicholls' (1943) treatment. Our redescription of this species revealed a second species of *Synamphisopus* from the Grampians, which we describe below.

Synamphisopus doegi sp. nov.

Figures 17–25

Material examined. Holotype. Victoria, small tributary of Glenelg R. crossing Sawmill Track, Grampians National Park, 37°21.44′S 142°17.79′E (GPS), sand under rocks and submerged wood, hand sieves, pH 5.5, 10.0°C, G. Wilson, R. Wetzer and S. Keable, 21 Sep 1999, VIC-96, NMV J40731 (male bl 23.3 mm, ethanol preserved).

Paratypes. As for holotype. AM P61253 (8 males, 5 females, 1 indeterminate ind.), AM P61434 (male bl 21.4 mm, dissected for illustration, SEM and description), AM P61435 (female bl 17.5 mm, dissected for SEM and description).

Other material. Vic., creek crossing Sawmill Track, tributary of Glenelg R., Grampians, 37°20.22′S 142°19.62′E (GPS), sand under rocks and leaf litter in stream, hand sieves, pH 6.45, 10.8°C, G. Wilson, R. Wetzer and S. Keable, 21 Sep 1999, VIC-95, AM P61254 (male, female, preserved in 95% ethanol); Vic., Sawmill Track, Glenelg R., Grampians, 37°21.75′S 142°16.90′E (map), T. Doeg, 17 Nov 1994, Gr1, AM P61255–6 (2 juvenile ind.); Vic., off Goat Road, tributary of Billimina Creek, Grampians, 37°14.22′S 142°19.07′E (map), T. Doeg, 15 Nov 1994, Gr49, AM P61257 (1 juvenile ind.); Vic., 50 m below The Fortress, Grampians, 37°18.80′S 142°18.00′E (estimate), J.E. Aslin, 26 Apr 1973, SAM C6027 (2 females).

Etymology. This species name honours Tim Doeg (Flora and Fauna Branch, Department of Natural Resources and Environment, Victoria, now at Northcote, Victoria) who sent us fresh specimens of *Synamphisopus* early in our project.

Diagnosis. *Pleotelson* medial dorsal ridge smoothly arcing, low, in lateral view projecting ventrally to form setose lobe below level of widely cleft medial lobe. *Mandible* palp article 2 with ventrolateral row of elongate setae, most longer than distal article; spine row shaft anterior margin with two separate dentate spines. *Maxillula* medial lobe rounded and broader distally than more proximally. *Maxilliped* palp article 5 suboval, short, length 1.6 width, lateral margin rounded. *Pereopod* 1 of adult male daetylus

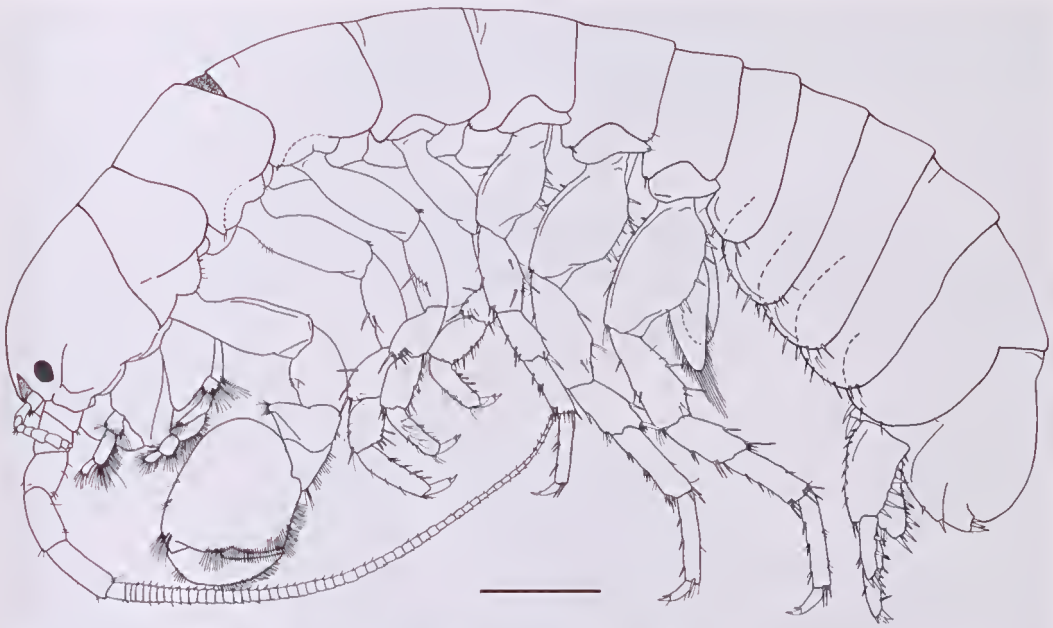

Figure 17. *Synamphisopus doegi*, sp. nov. Holotype (NMV J40731), lateral view. Scale bar 2 mm.

ventral margin convex, lateral face without pits but with ventrolateral row of setal groups; propodal palm heavily setose on medial margin, lacking large projecting spine. *Pereopods* II–IV basis proximal dorsal margin with row of simple setae, shorter than setal row in male, longer than setal row in female; male pereopod IV propodus ventral margin linear; pereopod VII propodus distomedial margin with setae longer than articular plate or dactylar claw. *Pleopod* II appendix masculina projecting beyond margin of proximal exopod article, with only 1 flattened tubercle on distomedial margin. *Uropod* protopod distoventral margin with 2 robust smooth setae and 1 additional small seta.

Description based on male. Coloration in 95% ethanol white legs, body slate gray-brown, head with black eyespot.

Eyes (figs 17, 18B, I) maximum diameter 0.18 head depth.

Pleonites (fig. 17) 1–4 relative lengths unequal, increasing in length from anterior to posterior, width 0.31 composite length in dorsal view.

Pleotelson (figs 17, 25A–E) lateral length 0.90 depth; dorsal length 1.65 width; depth 1.71 pereonite 7 depth. Medial lobe width 0.58 pleotelson width, greatest length 0.08 pleotelson total length.

Antennula (figs 18C–E) length 0.07 body length, with 9–10 articles. Article 5 length 1.0 width. Article 6 length 1.13 width. Numerous tiny aesthetases on article 5 to terminal article. Terminal article length 0.75 width.

Antenna (figs 18F–H) length 0.47 body length. Flagellum length 0.71 total antenna length, with 43–46 articles.

Mouthfield clypeus width 0.52 head width. *Mandible* (fig. 19) palp length 0.82 mandible length; article 3 with 14 setae; cuticular combs present; separate distal group of setae absent; articles 1–2 with groups of long setae (longer than half article length) on ventral lateral margins (along entire length of article 2). Left spine row with 25–27 spines (approximately but basally fused so how many bifurcate unclear), additional spines between peduncular projection and molar absent, first spine not separated from remaining spines. Right spine row with 19–25 spines (approximately but basally fused so how many bifurcate unclear), additional spines between peduncular projection and molar absent. Molar process with complex setulate spines forming posterior row. *Maxillula* (figs 20B–D) medial lobe length 0.8 lateral lobe length, width 0.73 lateral lobe width, with 3 pappose setae; with 2 'accessory' setae, one between distolateral pappose setae and one between distomedial pappose setae, 'accessory' setae distally denticulate. Lateral lobe distal margin with 20 smooth robust setae, distal setal row with 5 robust setae; ventral face with 3 plumose setae. *Maxilla* (figs 20E–G) medial lobe width 1.29 outer lateral lobe width. Outer lateral lobe width subequal to inner lateral lobe. *Maxilliped* (figs 20H–I) endite with 7 coupling hooks on right side; dorsal ridge with 25–27 large distally denticulate plumose setae (approximately). Palp article 4 subcircular, article 5 length 0.7 article 4 length.

Pereopod I (figs 21D–H) dactylus projecting beyond palm, length 1.1 palm length; distoventral margin

Figure 18. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434), paratype female (AM P61435). A–B, male head, dorsal and lateral views. C, male antennula. D, male antennula article 3 rudimentary second flagellum. E, male antennula distal artieles. F–H, male antenna. I, female head lateral view. J–K, female antennula. Scale bar 0.5 mm.

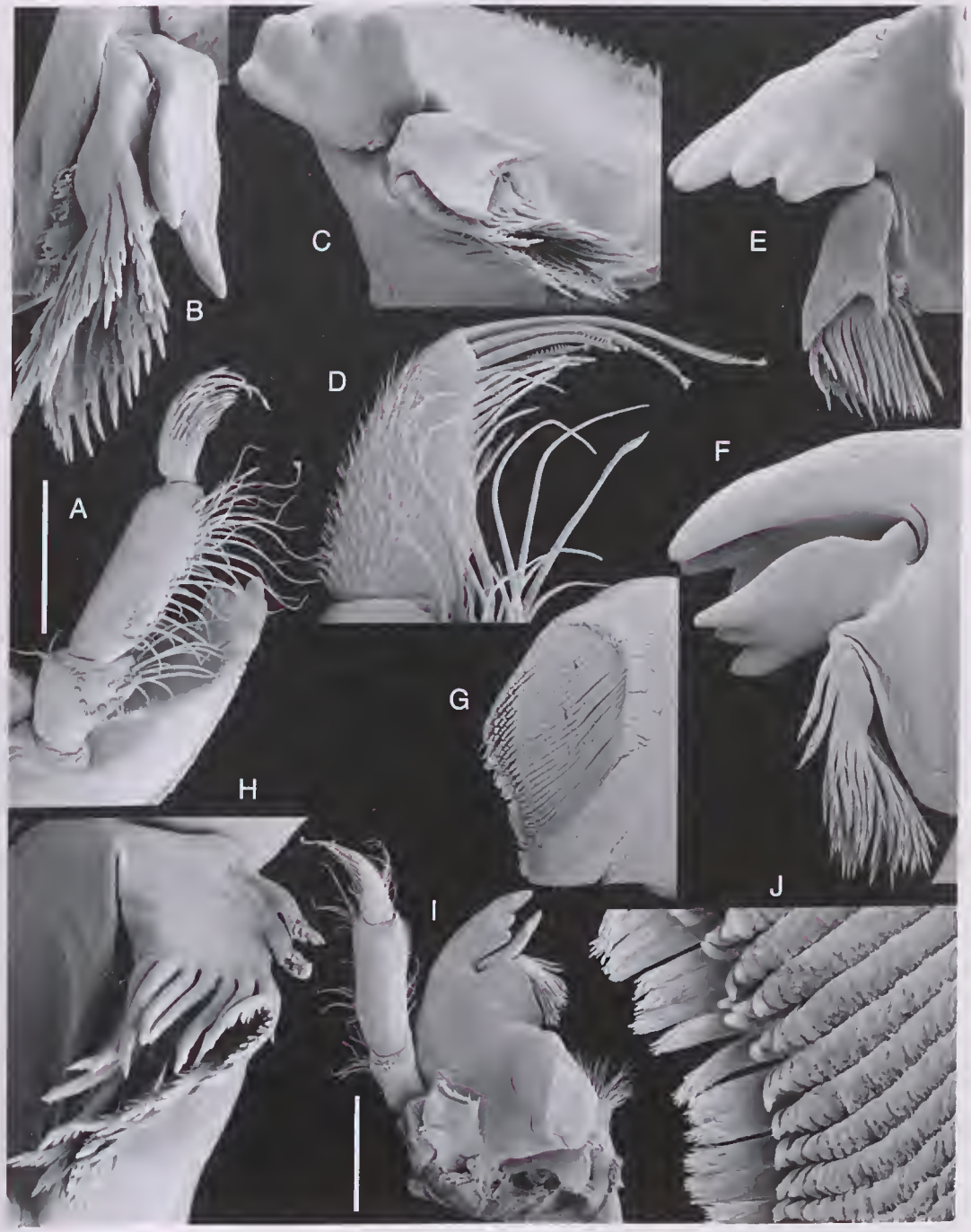

Figure 19. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434). A–E, right mandible. F–J, left mandible. Scale bar 0.5 mm.

Figure 20. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434). A, paragnaths. B–D, maxillula. E–G, maxilla. H–I, maxilliped. Scale bar 0.5 mm.

Figure 21. *Synamphisopus doegi*, sp. nov. Paratype female (AM P61435), paratype male (AM P61434). A–C, female pereopod I. D–H, male pereopod I. Scale bar 1 mm.

Figure 22. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434), paratype female (AM P61435). A, male pereopod II. B–C, male pereopod IV. D, female pereopod IV. E–G, male pereopod VII, including proximal articles, with penes. Scale bar 1 mm.

spines positioned along 0.59 total length. Propodus dorsal margin setae present in several groups between proximal and distal margin. Propodal palm without stout denticulate setae. Basis ventrodistal margin with 1 elongate seta. *Pereopod* IV (figs 22B–C) propodus ventral margin with 2 robust setae distinctly larger than others.

Penes (fig. 22G) length 0.37 body width at pereonite 7, with setae on tip.

Pleopod I length 0.11 body length; exopod length 2.25 width; endopod length 2.28 width, 0.82 exopod length. *Pleopod* II exopod length 2.25 width; exopod distal article length 0.37 exopod length; endopod length 1.91 width, 0.63 exopod length. *Pleopod* III exopod

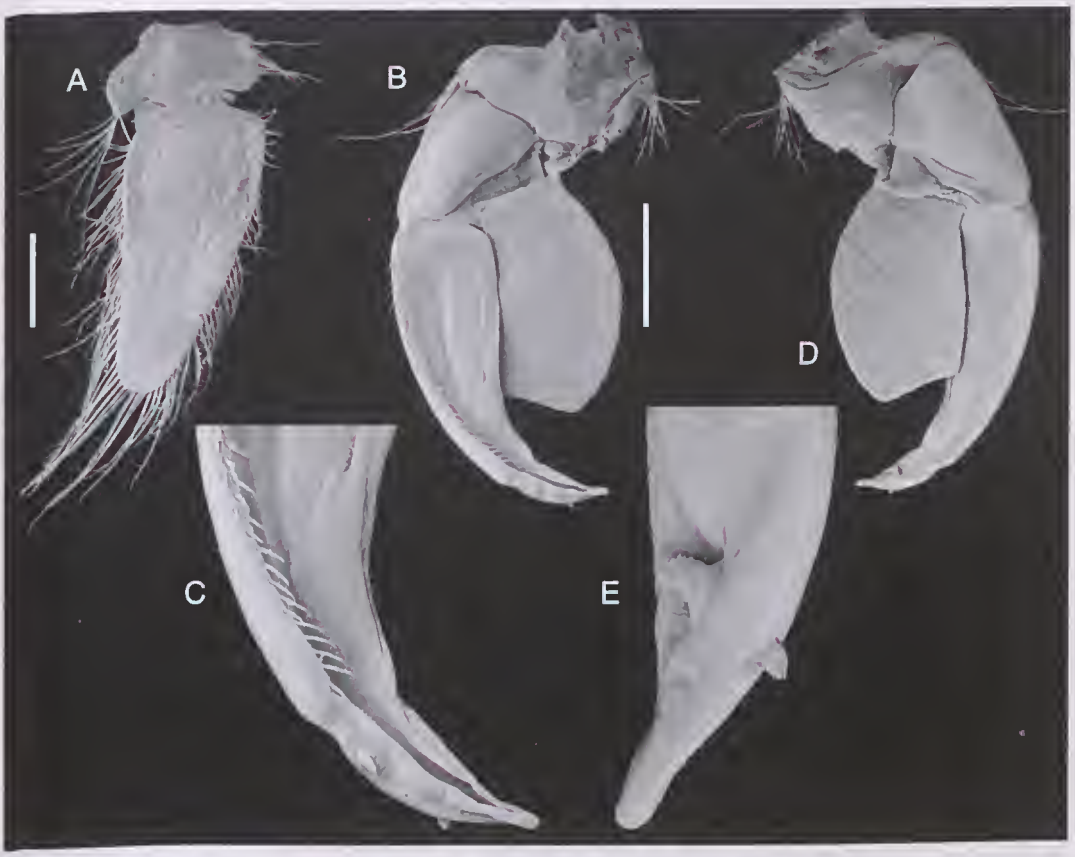

Figure 23. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434). A, pleopod I. B–E, pleopod II appendix maseulina and endopod. Seale bar 0.5 mm.

length 1.75 width; exopod distal artiele length 0.35 exopod length; endopod length 0.78 exopod length. *Pleopod* IV exopod length 1.6 width; endopod length 2.03 width, 0.85 exopod length. *Pleopod* V exopod length 1.67 width; exopod distal artiele length 0.33 exopod length; endopod length 1.66 width, 0.61 exopod length. *Pleopod* II endopod appendix maseulina with 48 setae on medial margin; length 0.59 pleopod length.

Uropod (fig. 25) total length 1.2 pleotelson length. Protopod length 2.73 width, 0.42 uropod total length. Endopod with 7–8 robust setae. Exopod length 0.69 endopod length; dorsal margin with 5 robust setae.

Sexual dimorphism and female characters. Antenna length 0.4 body length; flagellum with 39–40 artieles. *Pereopod* I (figs 21A–C) propodal palm with 9 stout dentieulate setae; robust simple setae basally inflated (diffieult to see behind lateral plumes of setae). *Pereopod* IV (fig. 22D) propodus ventral margin with 3 broad based setae on ventral margin (with additional 4 submarginally). *Pleopod* protopod II lateral margin with 8 simple setae proximally. *Uropod* endopod dorsal margin with 5 robust setae.

Distribution. Glenelg R. drainage, Grampians National Park.

Remarks. Synamphisopus doegi sp. nov. differs from *S. ambigmus* in several features, making the two speeies easy to distinguish. The pleotelson medial ridge of *S. doegi* extends ventrally and is produeed in a setose lobe, rather than terminating dorsally. The uropod protopod distoventral margin robust setae are smooth rather than spinose. The appendix maseulina medial margin setae tend to form two rows basally, although a remnant (or preeursor) of these setae can be seen in the *S. ambigmus*. The pereopod I propodal palm of *S. doegi* males laeks a spine. This new speeies also laeks punetae on the daetylus of pereopod I that are distinetive in *S. ambigmus*. The two speeies differ in the degree of setation on the body, *S. doegi* generally being more setose than *S. ambiguis* in homologous positions.

Figure 24. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434). A–E, pleopods I–V. Scale bar 1 mm.

Figure 25. *Synamphisopus doegi*, sp. nov. Paratype male (AM P61434). A–E, pleotelson and uropod, ventral, dorsal, lateral and posterior views. F, uropod protopod distal margin, ventral view. G, uropod, medial view. Scale bar 0.5 mm.

Synamphisopus ambiguus (Sheard)

Figures 26–33

Amphisopus ambiguus Sheard, 1936: p.469, figs 1–18.

Synamphisopus ambiguus. Nicholls, 1943: 96, fig. 24.

Type material. Holotype. Victoria, Fish Falls, Mackenzie R., Grampians, 37°07′S, 142°26′E (estimate), SAM C 2115 (carcass), C 2116 (slides lost).

Material examined. Series from Vic., Grampians, collected G. Wilson, R. Wetzer and S. Keable, Sep 1999, preserved in 95% ethanol – top of Mackenzie Falls, Mackenzie R., 37°06.70′S 142°24.58′E (GPS), seep at side of path, hand sieve, pH 6.9, 8.9°C, 20 Sep, VIC-84, AM P61258 (1 ind.); Vic., base of Mackenzie Falls, Mackenzie R., 37°06.74′S 142°24.52′E (GPS), gravel, sand, mud under rocks in seeps, hand sieves, 20 Sep, VIC-85, AM P61259 (8 ind.); Vic., base of Fish Falls, Mackenzie R., 37°06.59′S 142°24.01′E (GPS), sand under roots of ferns in seeps to side of main falls near seep sources, hand sieves, hand and spoon, pH 6.6, 10.6°C, 20 Sep, VIC-86, AM P61260 (5 males, 3 females), AM P61440 (male bl 24.1 mm, dissected for illustration, SEM and description, collection details as

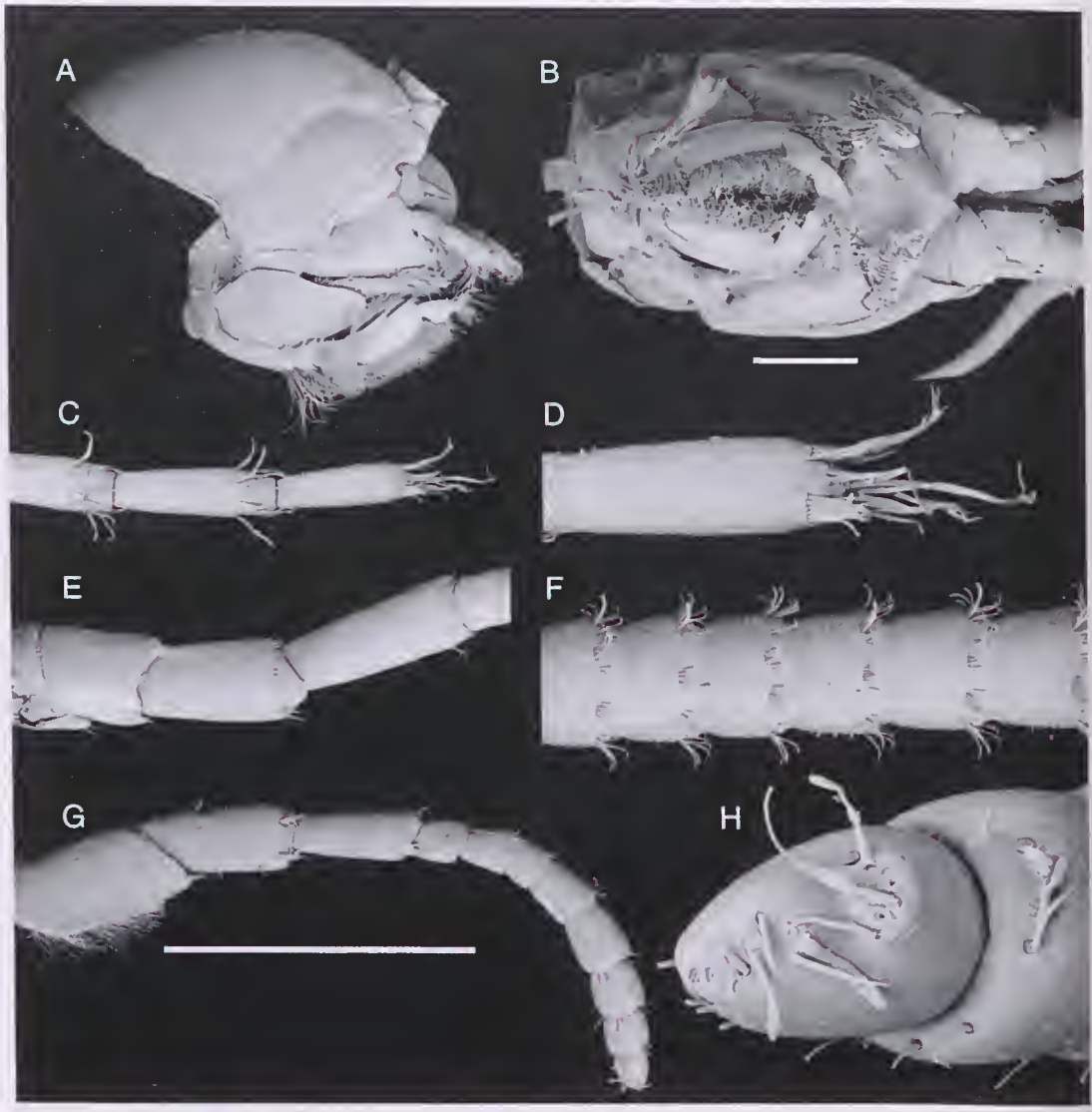

Figure 26. *Synamphisopus ambiguus*. Female (AM P61441), male (AM P61440). A–B, female head, lateral and ventral views. C–F, male antenna. G–H, male antennule. Scale bar 1 mm.

for P61260), AM P61441 (female bl 26.6 mm, dissected for SEM and description, collection details as for P61260), AM P61442 (male bl 28.2 mm, dissected for SEM and description, collection details as for P61260), AM P61443 (female bl 25.5 mm, dissected for SEM and description, collection details as for P61260); Vic., Stony Creek below Turret Falls on Twin Falls Trail, 37°09.41′S 142°29.90′E (GPS), from gravel under rocks, hand sieves, pH 6.7, 7.2°C, 21 Sep, VIC-89, AM P61261 (16 ind.); Vic., Stony Creek below Turret Falls on Twin Falls Trail, 37°07.93′S 142°30.26′E (GPS), fern roots at stream side, hand sieves, 21 Sep, VIC-90, AM P61262 (1 ind.); Vic., Stony Creek directly below Turret Falls on Twin Falls Trail, 37°09.66′S 142°29.83′E (GPS), from water weed, hand sieves, 21 Sep, VIC-92, AM P61268 (1 ind. and 1 carcass); Vic., base of Beehive Falls near Roses Gap, 36°58.54′S 142°27.01′E (GPS), under rocks in pool and leaf litter in stream, hand sieves, pH 4.6, 10.3°C, 22 Sep, VIC-97, AM P61269 (2 ind.). Vic., off Silverbrand Road, Stony Creek, Grampians, 37°09.20′S 142°29.67′E (map), T. Doeg and J. Read, 15 Nov 1994, site GR19, AM P54103 (1 male bl 26.2 mm, dissected, 1 preparatory female bl 24.9 mm, dissected); Vic., Stony Creek, near

Figure 27. *Synamphisopus ambiguus*. Male (AM P61440). A–C, left mandible. D–H, right mandible. Scale bar 0.5 mm.

Figure 28. *Synamphisopus ambiguus*. Male (AM P61440). A, paragnaths. B–C, maxillula. D–E, maxilla. F–H, maxilliped. I, left mandible molar. J, right mandible molar. Scale bar 0.5 mm.

Figure 29. *Synamphisopus ambiguus*. Male (AM P61440). A–F, pereopod 1. Scale bar 1 mm.

Halls Gap, Grampians, 37°09.72′S 142°29.74′E (map), altitude 510 metres, kick sample, D. Crowther, 10 Dec 1998, 98-220 Site 87, AM P61294 (1 ind.), AM P61295 (2 ind., collection details as for AM P61294 but not kick sample); Vic., 2 km from Zumsteins along road to Halls Gap, Grampians, 37°05′S 142°25′E (estimate), under rocks in fine sand sprayed with water from small trickle over cliff (on uphill side of road) onto rock ledge below, J.H. Bradbury, 29 Mar 1995, JHB VIC#24, AM P53150 (11 ind.); Vic., The Grampians (37°17′S, 142°33′E), A. Neboiss, 1 Oct 1954, NMV J44897 (3, labelled as *Phreatoicopsis terricola*); Vic., Briggs Bluff, Mt Rosea (36°59′S, 142°28′E), I.R. McCann, March 1957, NMV J44889 (1, labelled as *Phreatoicopsis terricola*).

Diagnosis. *Pleotelson* medial dorsal ridge with posterior obtuse angle, in lateral view projecting only to posterior margin above level of widely cleft medial lobe. *Mandible* palp article 2 with ventrolateral setae shorter than distal article; spine row shaft anterior margin without separate dentate spines. *Maxillula* medial lobe tapering distally. *Maxilliped* palp article 5 elongate, length 2.4 width, lateral margin linear. *Pereopod* 1 of adult male dactylus ventral margin sinuous, lateral face with regularly spaced setal pits; propodal palm with setal rows on proximal medial and lateral surfaces, with large spine midlength. *Pereopods* II–IV basis proximal dorsal margin with single robust seta; *pereopod* IV propodus ventral margin convex; *pereopod* VII propodus disto-medial margin with setae shorter than articular plate or dactylar claw. *Pleopod* II appendix

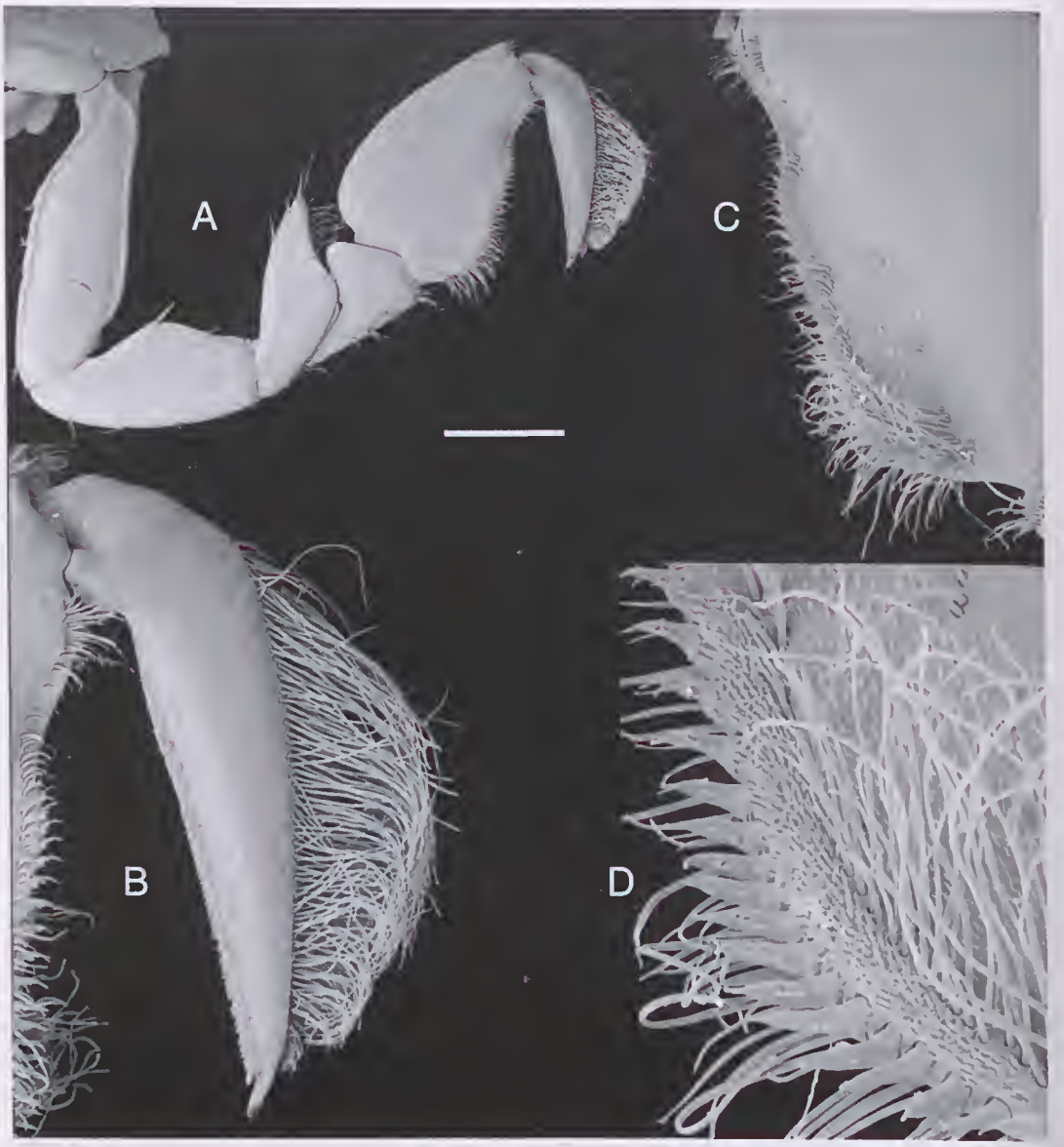

Figure 30. *Synamphisopus ambiguus*. Female (AM P61441). A–D, pereopod 1. Scale bar 1 mm.

masculina not projecting beyond margin of proximal exopod article, with 2 flattened tubercles on distomedial margin. *Uropod* protopod distoventral margin with 3 robust spinose setae.

Description based on male. Coloration in life white (colourless) legs, body slate gray-brown, head with tiny white eyespot; similar in 95% ethanol but eyespot black.

Eyes (fig. 26A) maximum diameter 0.12 head depth.

Pleonites 1–4 relative lengths subequal, width 0.55 composite length in dorsal view.

Pleotelson (figs 33A–E, G) lateral length 0.94 depth; dorsal length 1.46 width; depth 1.64 pereonite 7 depth. Medial lobe width 0.54 pleotelson width, greatest length 0.02 pleotelson total length.

Antennula (figs 26G–H) length 0.09 body length, with 11 articles. Article 5 length 1.29 width. Article 6 length 0.75 width. Numerous tiny aesthetases on article 8 to terminal article. Terminal article length subequal to

Figure 31. *Synamphisopus ambiguus*. Male (AM P61440), female (AM P61441). A–B, male pereopod II. C–D, male pereopod IV. E, female pereopod IV. F–H, male pereopod VII, including proximal articles, with penes. I–J, male pleopod II appendix masculina and endopod. Scale bar 1 mm.

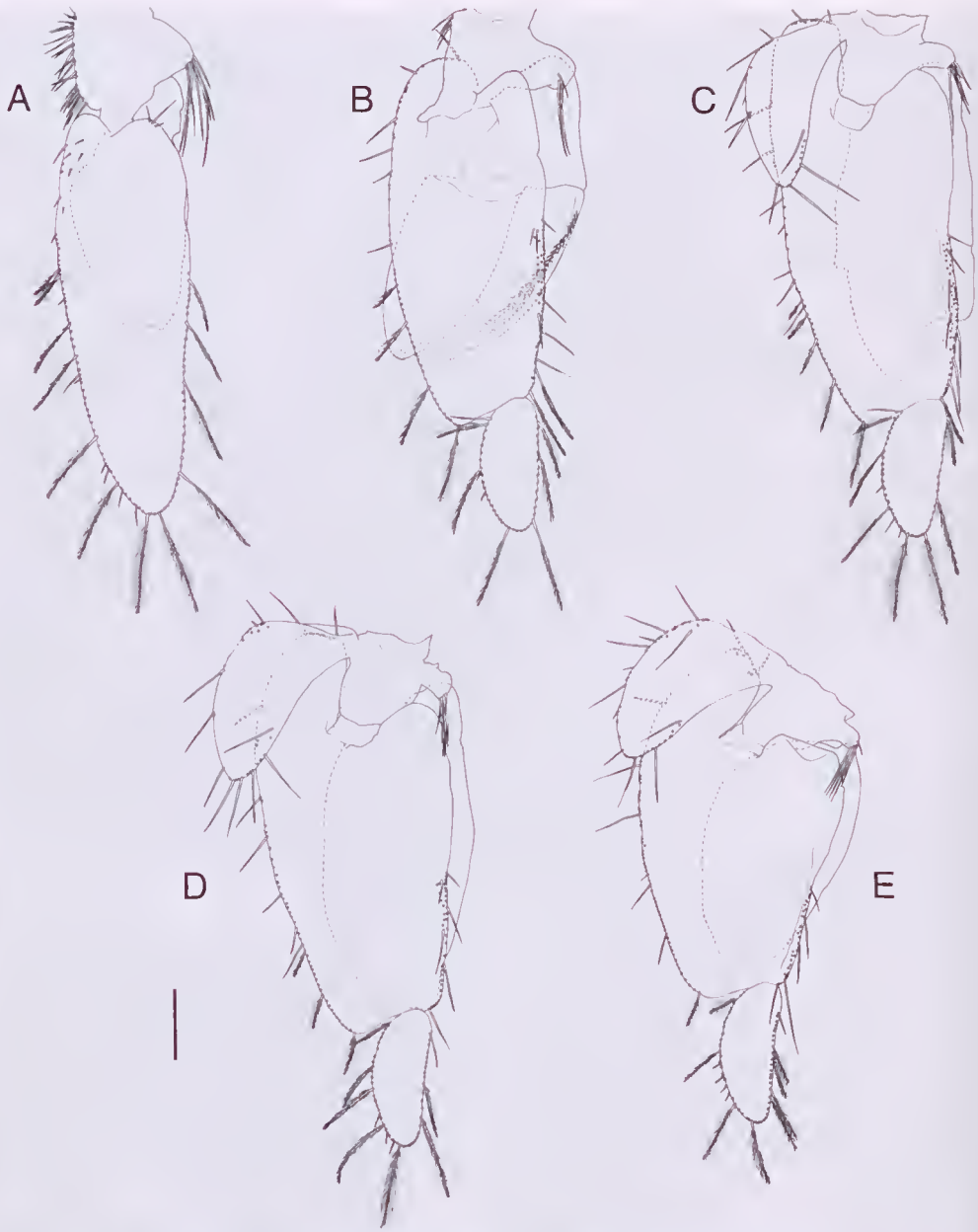

Figure 32. *Synamphisopus ambiguus*. Male (AM P61440). A–E, pleopods I–V. Scale bar 1 mm.

penultimate article length, 1.36 width. *Antenna* (figs 26C–F) length 0.51 body length. Flagellum length 0.67 total antenna length, with 54 articles (40 articles in illustration: Sheard, 1936).

Mouthfield clypeus width 0.46 head width. *Mandible* (figs 27, 28I–J) palp length 0.88 mandible length, article 3 with 23 setae, cuticular combs absent; separate distal group of setae present; articles 1–2 with groups of long setae (longer than half article length) on ventral lateral margins. Left spine row with 36 spines (approximately but basally fused so how many bifurcate unclear), first spine separated from remaining spines. Right spine row with 33 spines (approximately, basally fused so how many bifurcate unclear). Molar process

Figure 33. *Synamphisopus ambiguus*. Male (AM P61440). A–C, G, pleotelson, dorsal, lateral and ventral views. D–E, pleotelson and uropod, lateral view. F, uropod protopod distal margin, ventral view. H, pleopod I. Scale bar 1 mm.

spines absent. *Maxillula* (figs 28B–C) medial lobe length 0.76 lateral lobe length, width 0.5 lateral lobe width, with 4 pappose setae, with 1 'accessory' seta between central pappose setae, 'accessory' setae simple. Lateral lobe distal margin with 29 smooth robust setae, distal setal row with 4 robust setae; ventral face with 4 plumose setae. *Maxilla* (figs 28D–E) medial lobe width 1.86 outer lateral lobe width. Outer lateral lobe wider than inner lateral lobe. *Maxilliped* (figs 28F–H) endite with 5 coupling hooks on right side; dorsal ridge with at least 20 large distally-denticulate plumose setae. Palp article 4 elongate-distally expanded, article 5 length 1.09 article 4 length.

Pereopod I (figs 29A–F) dactylus only slightly shorter than palm, length 0.94 palm length. Propodus dorsal margin setae confined to single group at distal margin. Propodal palm with stout denticulate serrate setae. Basis ventrodistal margin lacking elongate setae. *Pereopod* IV (figs 31C–D) propodus ventral margin with 3 robust setae distinctly larger than others, central seta largest.

Penes (fig. 31H) length 0.5 body width at pereonite 7; setae absent.

Pleopods (figs 31I–J, 32) I length 0.15 body length; exopod length 2.88 width; endopod length 2.0 width, 0.61 exopod length. *Pleopod* II exopod length 2.79 width; exopod distal article length 0.3 exopod length; endopod length 2.98 width. 0.69 exopod length. *Pleopod* III exopod length 2.12 width; exopod distal article length 0.33 exopod length; endopod length 0.72 exopod length. *Pleopod* IV exopod length 2.4 width; endopod length 2.34 width, 0.75 exopod length. *Pleopod* V exopod length 1.83 width; exopod length of distal article 0.38 exopod length; endopod length 1.78 width, 0.67 exopod length. *Pleopod* II endopod appendix masculina with 23 setae on medial margin; length 0.38 pleopod length.

Uropod (figs 33D–E) total length 1.06 pleotelson length. Protopod length 3.46 width, 0.38 uropod total length. Endopod with 12 robust setae (including 5 at distal tip). Exopod length 0.76 endopod length; dorsal margin with 6 robust setae (including 3 at distal tip).

Sexual dimorphism and female characters. Antenna length 0.45 body length; flagellum with 42 articles. *Pereopod I* propodal palm with 20 stout robust conical setae. *Pereopod IV* propodus ventral margin with 5–6 broad based setae on ventral margin (and additional 3–5 submarginally); robust simple setae absent. *Pleopod* protopod II lateral margin with 4 simple setae proximally. *Uropod* endopod dorsal margin with 13 robust setae

Distribution. Stony Creek and Mackenzie R. drainages, and Beehive Falls, Grampians National Park, Victoria.

Remarks. Synamphisopus ambiguus populations vary in at least one feature. Specimens from Fish Falls on Mackenzie R. (the type locality) all have 3–4 robust setae on each side of the cleft pleotelson tip, while specimens from other locations sometimes have more. Specimens from Stony Creek and from Mackenzie Falls (Mackenzie R. above Fish Falls) have 5–6 setae in this position, while most other specimens, including that from Beehive Falls to the north of the type locality, have 3–4 setae. Sheard (1936) states that the coxae of all legs are fused, that the fourth pereopod is not sexually differentiated and that appendix masculina lacks setae; our material does not support these observations.

Phreatoicidae Chilton

Phreatoicidae Chilton, 1891: 151.

Diagnosis. Head tubercles absent; antennal notch shallow, without posterior extension. *Pleonite* 1 pleura distinctly shallower than pleurae of pleonites 2–5. *Pleotelson* posterior margin entire, reflexed dorsally, produced. *Antennal* article 3 rudimentary second flagellum absent. *Mandible* right lacinia mobilis reduced, incorporated into spine row, with tooth or denticulated scale on anterior face; spine rows linear on pedunculate projection. *Pereopod I* merus dorsal projection shelf-like and U-shaped. *Pereopods* II–III propodus with articular plate on posterior side of limb; percopod IV sexually dimorphic, prehensile in adult males. *Pleopod* exopods II–V with lateral proximal lobes; protopods medial margin without coupling hooks; protopods I–II lateral epipod absent, III–V lateral epipods lobe-like. *Uropod* rami distal tips pointed.

Remarks. The Phreatoicidae includes a diverse group of taxa, united by reduction of the right lacinia mobilis, which is fused into the distal member of the spine row. Additionally, the spine rows on both mandibles are pedunculate. The phreatoicid spine rows are notably different from fused spines found in the *Synamphisopus* + *Phreatoicopsis* clade (discussed above) because the individual bifurcate spines in the Phreatoicidae are distinct and aligned parallel in a dorsoventral plane. Other features that define the Phreatoicidae are homoplastic, being shared with members of the Amphisopodidae and Hypsimetopodidae. Material from the Grampians contains four species of Phreatoicidae that could not be assigned to any existing genera. The phylogenetic analysis shows that these species are monophyletic, but we cannot diagnose this clade with unambiguous apomorphic features, although three of the species have several synapomorphies. Accordingly, we introduce the genera *Naiopegia* gen. nov. and *Gariwerdeus* gen. nov. to accommodate these species.

Naiopegia gen. nov.

Type Species. Naiopegia xiphagrostis sp. nov.

Etymology. The genus name is compounded from the Greek words "Naio", meaning to dwell or inhabit, and "Pege" (f.) for spring.

Diagnosis. Cephalon without eyes, cuticle rugose with cuticular hairs, with elongate setae (longer than basal 2 articles of antennula), especially at ventrolateral margins; clypeal notch present (but weak). *Typhlosole* minimal, ventral invagination forming laminar projection in cross section. *Pleotelson* dorsal surface rugose with cuticular hairs, without abundant long setae; medial and lateral lobes distinct; lateral lobes rounded; medial lobe reflexed, projecting beyond lateral lobes, with 4 robust setae. *Antennula* with 6 (rarely 7) articles, penultimate article elongate and inflated, terminal article shorter than broad, not compound, much shorter than article 5. *Antenna* basal articles of flagellum with dense cuticular hairs. *Mandible* palp articles 1 and 2 with row of elongate setae (longer than distal article); right lacinia mobilis anterior scale with 4 robust denticles. *Maxilliped* basis distal margin adjacent to palp insertion with elongate setae (longer than palp articles 1–3). *Pereopod* I not strongly dimorphic, propodus of male only somewhat broader than female and dorsal margin not produced proximally; propodal palm concave, spines absent, with stout conical robust setae in male, denticulate robust setae in female, cuticular fringe weakly developed, setal ridge absent. *Pereopods* I–VII proximal portions (basis, merus, ischium) with numerous elongate setae (many longer than ischium) on dorsal and ventral margins; basis dorsal ridge in cross section rounded on pereopod V, angular on *pereopods* VI–VII. *Pleopod II* endopod appendix masculina proximal half of shaft solid and rod-like, indented in ventral cross section, lacking setae on lateral or medial margins. *Uropod* protopod distoventral margin with 1 robust spinose seta and several simple setae.

Remarks. We introduce a monotypic genus because *Naiopegia xiphagrostis* gen. nov., sp. nov. shares no unambiguous synapomorphies with other genera of the Phreatoicidae. This species has a typical phreatoicid body and limb form, but no species of this family have cuticular hairs on the basal articles of the antennae. Its "reduced" antennule, another diagnostic and apomorphic character, is broadly homoplastic, being found in taxa outside of the Phreatoicidae, such as *Crenisopus* and some species of *Mesamphisopus*. Species of *Gariwerdens* gen. nov. also have similar six-articled antennulae (see below), but with a differing composition of the distal two articles. *Naiopegia* lacks the distinctively formed pleotelson of *Gariwerdens* and is similar in this regard to other phreatoicids. Of the blind, but more typical phreatoicids, the cross sectional shape of the appendix masculina as well as the cuticular hairs on the antennula would separate *Naiopegia* gen. nov. from *Crenoicus*.

Naiopegia xiphagrostis sp. nov.

Figures 34–41

Material examined. Holotype. Victoria, tiny spring-fed tributary of Stony Creek below Turret Falls, at bridge on Twin Falls Trail, Grampians National Park, 37°07.93′S 142°30.26′E (GPS), sand with mud and detritus in minimal seep flow among thicket of sword grass, hand sieve, S. Keable, 21 Sep 1999, VIC-91, NMV J40732 (male bl 12.0 mm, ethanol preserved).

Paratypes. As for holotype. AM P61270 (4 males), AM P61424 (1 male bl 11.7 mm, dissected for illustration, SEM and description), AM P61425 (1 female bl 7.4 mm, dissected for SEM and description), AM P61426 (male bl 11.1 mm, used to supplement description and SEM).

Etymology. The species name is a noun in apposition from the Greek compound name for sword grass, "xiphagrostis", and refers to the vegetation found at the type locality.

Description based on male. Coloration in life with white patches on head in eye region, gray dorsum darker at edges; in 95% ethanol, uniform gray-white.

Head (figs 35B–C) length subequal to width in dorsal view; width 0.81 pereonite 1 width; surface with dense cuticular hairs; setae sparse but forming dense row along ventral margin.

Pereon broad, width 1.2 head width; with scattered roughness (cuticular hairs).

Pleonites in dorsal view 2–4 respective lengths more than half length of pleonite 5; *pleonites* 1–4 relative lengths subequal, width 1.0 composite length in dorsal view.

Pleotelson (figs 41A–D) lateral length 0.12 body length, 0.77 depth; dorsal length 1.22 width; depth 1.5 pereonite 7 depth. Dorsal surface without abundant long setae. Medial lobe width 0.36 pleotelson width, greatest length 0.22 pleotelson total length. Lateral lobes in lateral view curving dorsally, in dorsal view rounded, not extending posteriorly to level of medial lobe, medial length 0.08 pleotelson total length, with 1 robust setae. Ventral margin anterior to uropods with 8 smooth setae, posterior seta subequal to anterior adjacent setae.

Antennula (figs 35B, D) length 0.07 body length, with 6 articles. 2–3 tiny aesthetases on articles 5–6. Articles 5 and 6 width subequal to article 4. *Antenna* (figs 35C, E, F–G) length 0.27 body length. Flagellum length 0.66 total antenna length, with 20 articles.

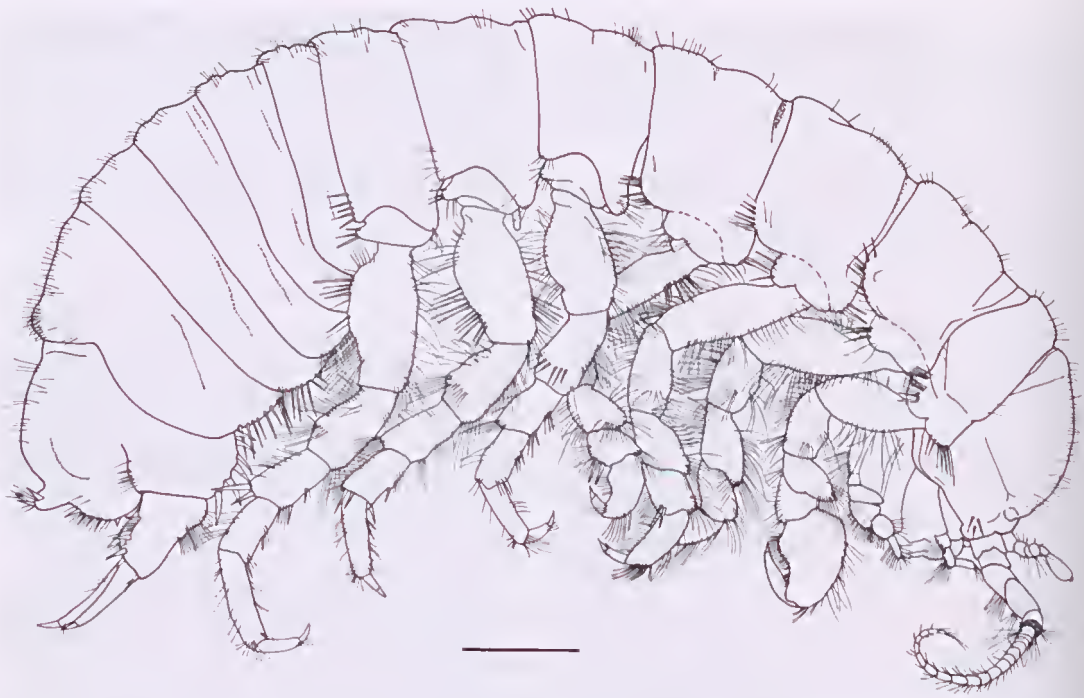

Figure 34. *Naiopegia xiphagrostis* gen. nov., sp. nov. Holotype male (NMV J40732), lateral view. Scale bar 1 mm.

Mouthfield elypeus width 0.56 head width. *Mandible* (fig. 36) palp length 0.74 mandible length; article 3 with 7 setae; separate distal group of setae absent; articles 1–2 with elongate setal row. Left incisor process with 2 distal cusps and 1 on dorsal margin (shoulder for fourth cusp apparent but not forming full cusp). Left spine row with 7 bifureate spines, without additional spines between pedunculate projection and molar. Right spine row with 7 bifureate spines in addition to lacinia mobilis, without additional spines between pedunculate projection and molar. Molar process longer than wide; 3–4 setulate spines forming posterior row. *Maxillula* (figs 37B–C) medial lobe length 0.83 lateral lobe length; width 0.65 lateral lobe width. Lateral lobe distal margin with 3 denticulate robust setae, 7 smooth robust setae. *Maxilla* (figs 37D–F) medial lobe width 0.71 outer lateral lobe width. *Maxilliped* (figs 37G–H) endite with 3 receptaculi on right side; dorsal ridge with 10–13 large distally denticulate plumose setae (merging with subdistal biserrate setae). Palp insertion on basis ventral surface with 10 subdistal smooth setae (some forming row).

Pereopod I (figs 38A–B) daetylus length 0.9 palm length; ventrodistal margin with row of sharp spines along 0.37 total length. Propodus dorsal margin with 21 setae in several groups between proximal and distal margin (exeluding distal group); proximal region not protruding. Propodal palm concave; stout denticulate setae absent; with 9 stout robust simple conical setae; elongate broad based setae absent. Basis ventrodistal margin with 10 elongate setae. *Pereopod* IV (figs 39C–D) daetylus shorter than propodal palm. Propodus with 7 broad based setae on ventral margin, 2 distinctly larger than others; articular plate subequal in length to daetylar claw. *Pereopods* V–VII (figs 39F–G) basis dorsal ridge in cross section rounded on pereopod V, angular on pereopods VI–VII.

Penes (fig. 39I) length 0.25 body width at pereonite 7, distally tapering.

Pleopod I (figs 40, 39H) exopod distal margin rounded, medial margin concave from proximal to distal half, subparallel to lateral margin, dorsal surface lacking setae. *Pleopod* II endopod appendix masculina length 0.61 pleopod length, distal tip truncate; with 5 setae on margin.

Uropod (figs 41A–E) total length 1.08 pleotelson length. Protopod length 0.42 uropod total length; ventral margin with anteriorly-projecting somewhat rigid long setae, forming dense longitudinal row, setae medially robust and distally spinose; distoventral margin with 1 robust spinose seta and 2 simple setae. Exopod length 0.87 endopod length.

Sexual dimorphism, female differences. Antennula length 0.06 body length, with 6–7 articles, article 5 length greater than article 6. *Antenna* length 0.34 body length, flagellum 0.61 total antenna length, with 16 articles (incomplete, distal most articles missing). *Pereopod* I (figs 38C–E) daetylus length 0.95 palm length; ventrodistal margin with row of 8 sharp spines, along 0.33 total length; propodal palm with 7 stout robust

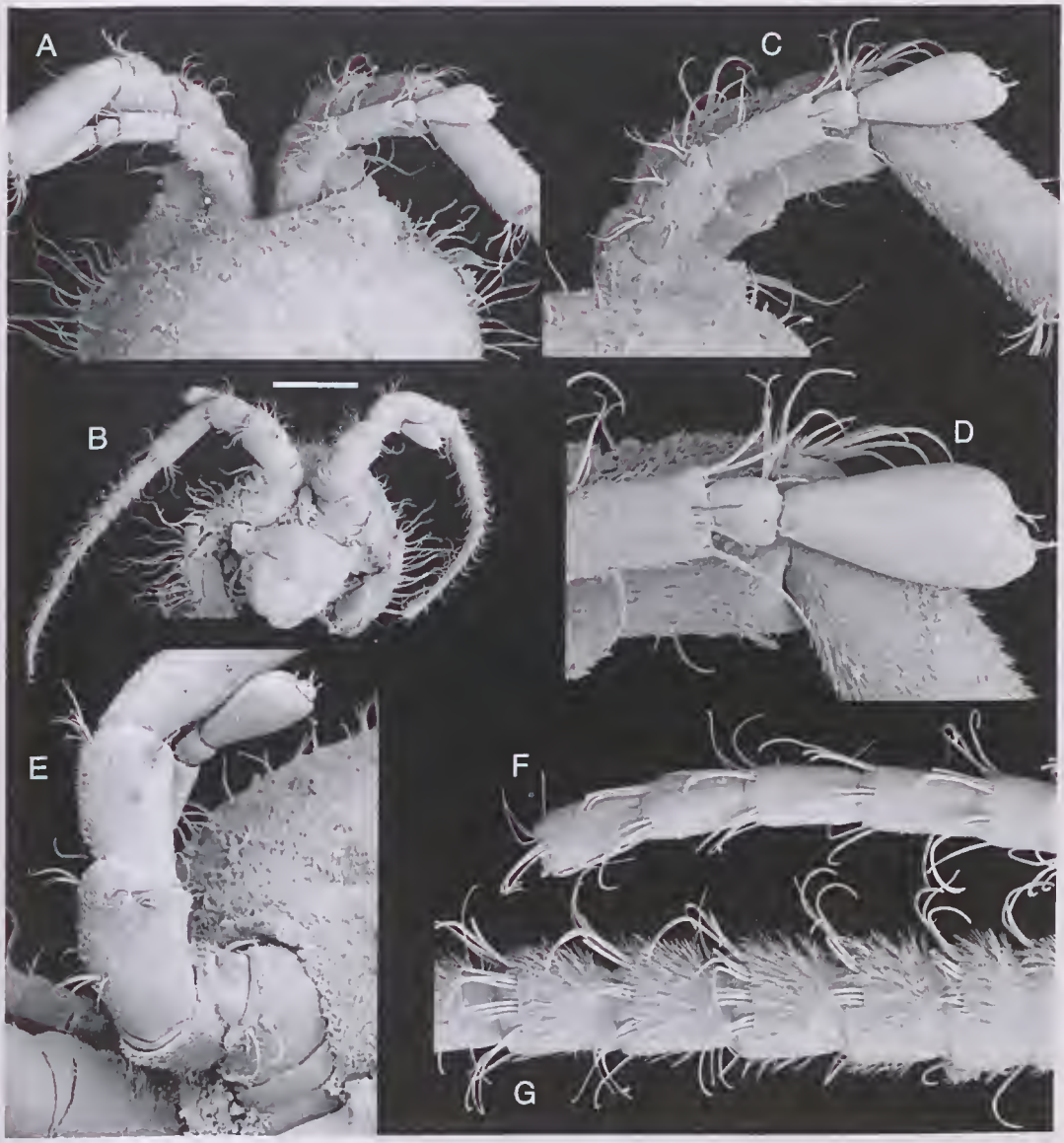

Figure 35. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424). A–B, head, antennula, antenna proximal articles, dorsal view. C, head, ventral view. D, antennula distal articles. E, antenna proximal articles, antennula distal articles. F–G, antenna flagellum distal and proximal articles. Scale bar 0.5 mm.

simple conical setae; basis ventrodistal margin with 8 elongate setae. *Pereopod* IV (fig. 39E) propodus articular plate shorter than dactylar claw. *Uropod* length 0.9 pleotelson length, 0.47 uropod total length, exopod length 0.74 endopod length.

Distribution. Known only from small spring-fed tributary of Stony Creek below Turret Falls, at bridge on Twin Falls Trail, Grampians National Park.

Remarks. This species is similar to most other phreatoicids, save for a few distinctive features and the lack of eyes. The elongate setae on all limbs and the inflated, distally-broadened antennular article 5 with a tiny, but distinct article 6 are diagnostic for this species. The antennular details and the plesiomorphic retention of a large reflexed medial lobe on the pleotelson also distinguish it from species of *Gariwerdeus* gen. nov.

Figure 36. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61426). A–C, left mandible. D–H, right mandible. Scale bar 0.1 mm.

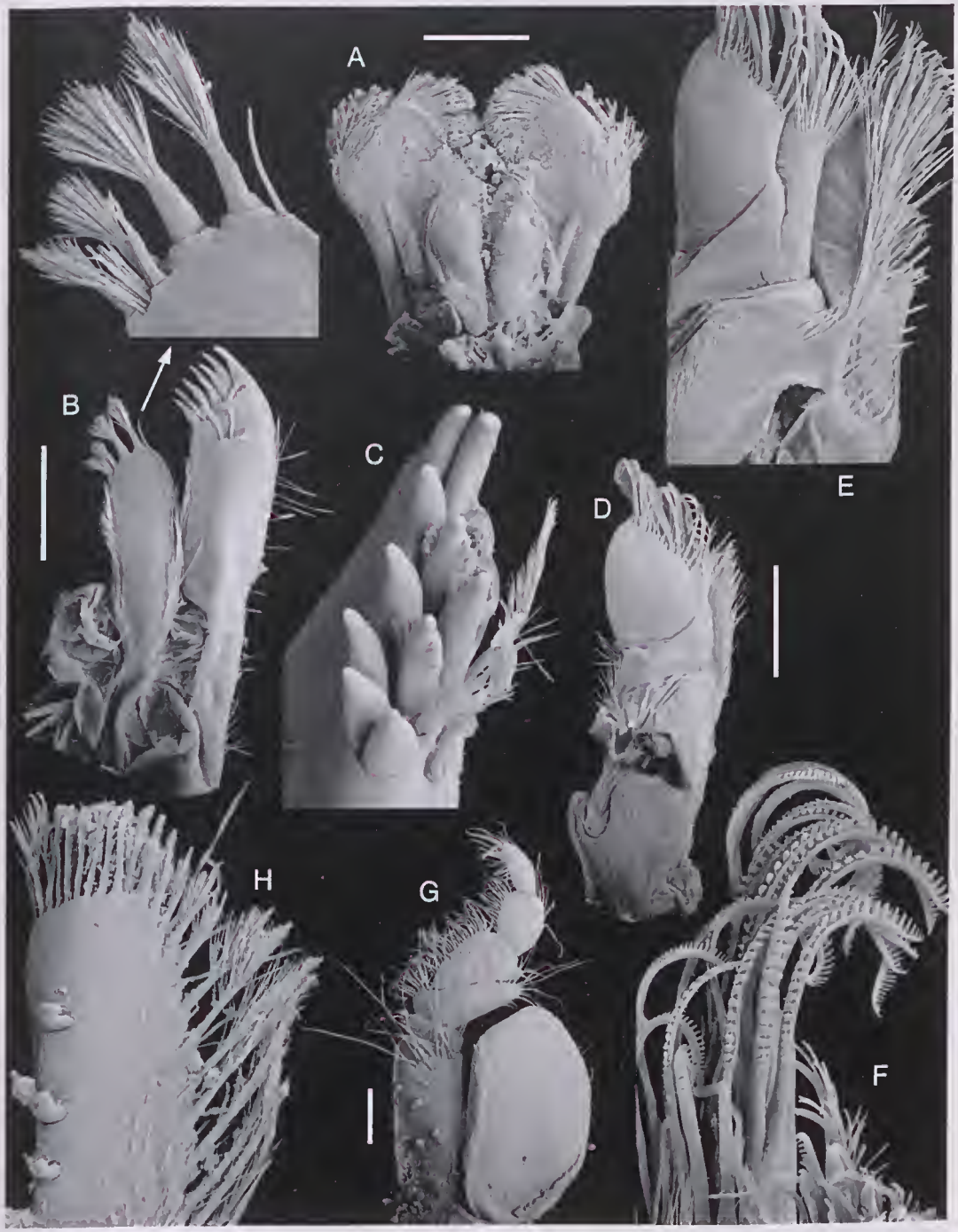

Figure 37. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424) A, G–H, paratype male (AM P61426) B–F. A, paragnaths. B–C, maxillula. D–F, maxilla. G–H, maxilliped. Scale bar 0.2 mm.

Figure 38. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424), paratype female (AM P61425). A–B, male pereopod 1. C–E, female pereopod 1. Scale bar 0.5 mm.

The number of distal antennulae articles may be variable among adults of *N. xiphagrostis* sp. nov. – one female has 6 on one side and 7 on the other.

Gariwerdeus gen. nov.

Type Species. Gariwerdeus turretensis sp. nov.

Etymology. The Grampians (an English name deriving from a mountain range in Scotland) National Park is given the name "Gariwerd" by the indigenous Jardwadjali and Djab Wurrung people. The species of this genus appear to be ubiquitious in streams, springs or groundwater seeps within the Park, and thus should bear the original name for this region. *Gariwerdeus* is treated as a masculine noun.

Diagnosis. Cephalon without eyes; clypeal notch absent. *Typhlosole* minimal, ventral invagination simple (either laminar or 'u' shaped in cross section). *Pleotelson* dorsal surface with abundant long setae and rugose with dense cuticular hairs; medial and lateral lobes distinct; posterior margin reflexed dorsally, medial lobe compressed anteriorly, shorter than lateral lobes; lateral lobes acutely angular in dorsal or ventral view, in lateral view depressed ventrally, protruding posteriorly from insertion of uropods. *Antennula* with 6 or fewer articles, distal articles inflated. *Antenna* flagellum proximal articles without dense cover of cuticular hairs. *Mandible* palp article 2 with elongate setal row (setae longer than distal article). *Pereopod* 1 propodal palm concave,

Figure 39. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424), paratype female (AM P61425). A–B, male pereopod II. C–D, male pereopod IV. E, female pereopod IV. F–G, male pereopod VII. H, male pleopod II appendix masculina. I, male pereopod VII proximal articles, with penes. Scale bar 0.5 mm.

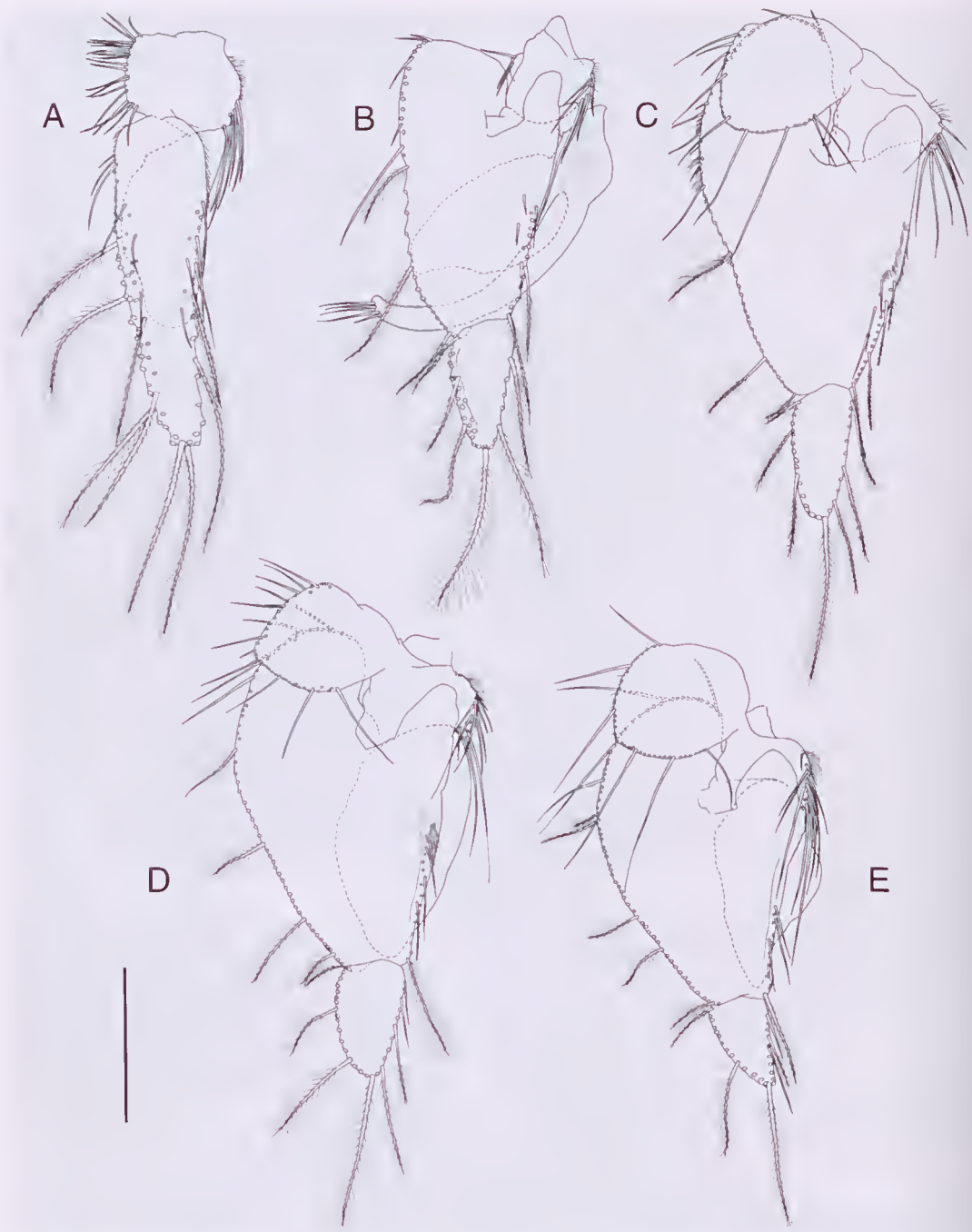

Figure 40. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424). A–E, pleopods I–V. Scale bar 0.5 mm.

Figure 41. *Naiopegia xiphagrostis* gen. nov., sp. nov. Paratype male (AM P61424). A–D, pleotelson and uropod, lateral, medial and ventral views. E, uropod protopod distoventral margin robust setae. F, pleotelson distal margin, dorsal view. Scale bar 0.5 mm.

spines absent, with stout conical robust, elongate or denticulate setae, setal ridge absent. *Pereopods* I–VII proximal portions (basis, merus, ischium) with numerous elongate setae (many longer than ischium) on dorsal and ventral margins; pereopod VII basis dorsal ridge in cross section angular. *Pleopod* II endopod appendix masculina proximal half of shaft solid and rod-like, indented in ventral cross section, lacking setae on lateral or medial margins. *Uropod* protopod distoventral margin with 1–2 robust spinose seta and several simple setae.

Remarks. In addition to having a setose, light coloured and rugose cuticle, species of *Gariwerdeus* gen. nov. can be recognised most readily by their greatly reduced pleotelson tip, giving an almost truncate appearance to the end of the body. This feature can be seen when collecting specimens in the field. All species of *Gariwerdeus* are also blind. The antennula is pauciarticulate, similar to that of *Naiopegia* gen. nov., but the distal articles differ in all of the *Gariwerdeus* species. Our cursory investigation of the Grampians has detected three species in this genus.

Gariwerdeus turretensis sp. nov.

Figures 42–49

Material examined. Holotype. Victoria, Stony Creek directly above Turret Falls on Twin Falls Trail, Grampians National Park, 37°09.62′S 142°29.82′E (GPS), sand, silt and fern roots at edge of creek, hand sieve, S. Keable, 21 Sep 1999, VIC-93, NMV J40733 (male bl 7.4 mm).

Paratypes. As for holotype. AM P61271 (20 ind.), AM P61427 (male bl 8.6 mm, dissected for illustration, SEM and description), AM P61428 (female bl 8.4 mm, dissected for SEM and description), AM P61429 (male bl 8.3 mm, used to supplement description and SEM).

Other material. Series from Vic., Stony Creek, Grampians, hand sieves, collected G. Wilson, R. Wetzer and S. Keable, 21 Sep 1999, preserved in 95% ethanol – below Turret Falls on Twin Falls Trail, 37°09.41′S 142°29.90′E (GPS), from vegetation at edge of stream in sand, pH 6.7 (out of calibration), 7.2°C, VIC-89, AM P61273 (12 ind.); below Turret Falls on Twin Falls Trail, 37°07.93′S 142°30.26′E (GPS), fern roots at stream side, VIC-90, AM P61274 (male, female); directly below Turret Falls on Twin Falls Trail, 37°09.66′S 142°29.83′E (GPS), from sphagnum at waters edge, hand sieves, VIC-92, AM P61272 (12 ind.) and NMV J40734 (male, 2 females). Vic., Stony Creek, Grampians, 37°09.72′S 142°29.74′E (map), stream riffles, altitude 510 metres, kick sampling, D. Crowther, 10 Dec 1998, 98-220 Site 87, AM P61257 (male).

Etymology. The name refers to Turret Falls on Stony Creek in The Grampians National Park, around which this species was collected.

Diagnosis. Pleotelson tip medial lobe lacking robust sensillate setae but with 8 fine simple setae. *Antennula* article 6 inflated and bulbous, terminal two segments with one aesthetase each, article 5 length subequal to article 6 length. *Mandible* right lacinia mobilis with 1 row of denticles. *Pereopod* I of male dactylus posterodistal margin smooth; propodus dorsal margin proximally produced, greatly expanded beyond dorsal margin of carpus; propodal palm cuticular fringe weakly developed. *Pereopods* II–IV basis dorsal margin elongate setae in row, not clustered. *Pleopod* II endopod appendix masculina distal tip truncate, with 3 setae on margin. *Uropodal* protopod distoventral margin with 1 robust spinose seta and 7 simple setae.

Figure 42. *Gariwerdeus turretensis* gen. nov., sp. nov. Holotype male (NMV J 40733), lateral view. Scale bar 1 mm.

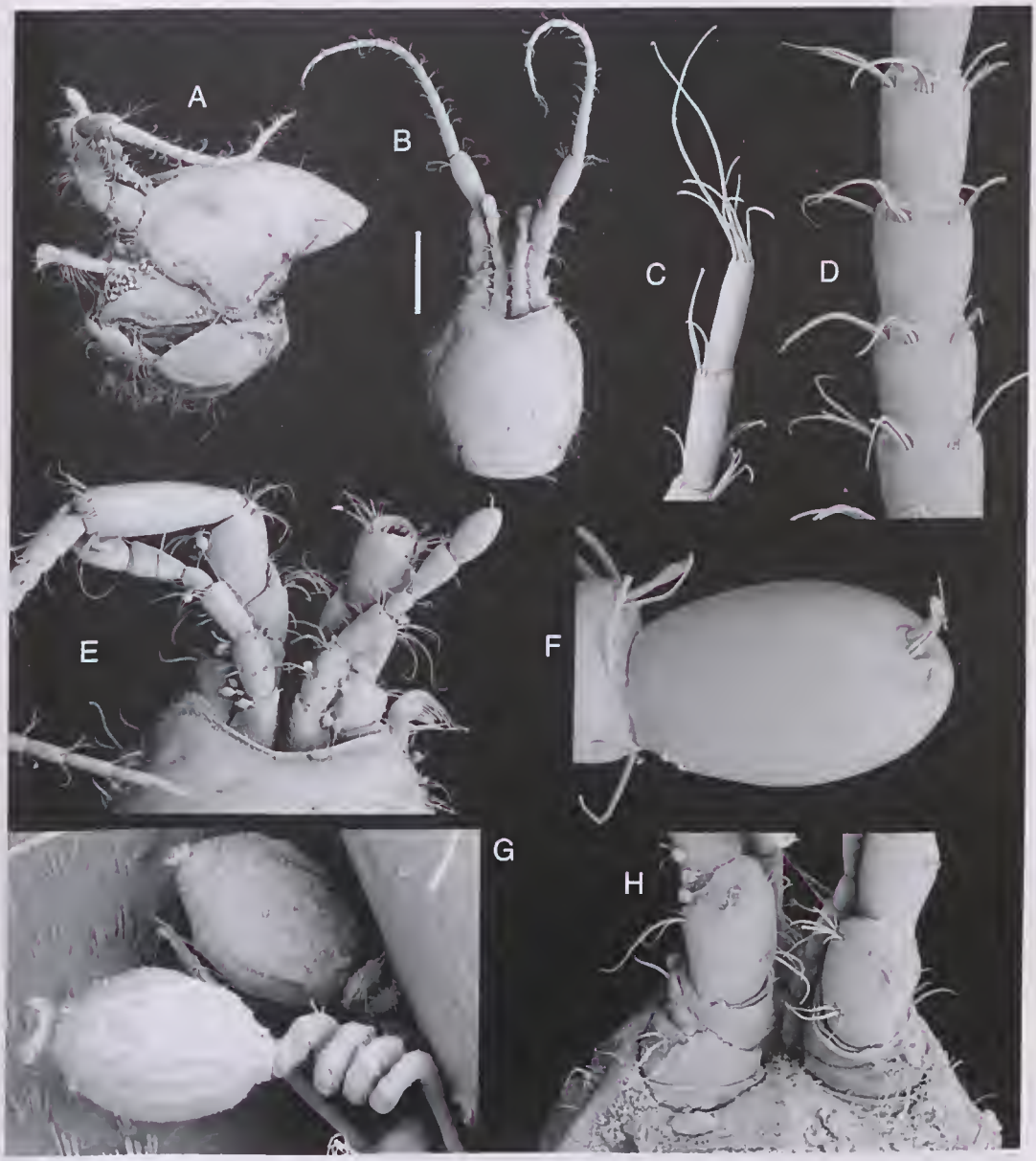

Figure 43. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61427) A–D, H, paratype female (AM P61428) E–G. A–B, H, male head, antenna, antennule, lateral, dorsal and ventral views. C–D, male antenna flagellum, distal and proximal articles. E, female head, antenna, antennula, dorsal view. F, female antennula, distal articles. G, ciliate protozoan epibiont (*Vorticella* sp.) on female antenna. Scale bar 0.5 mm.

Description based on male. Coloration in life translucent with dark patches on posterior pleonites, white dorsum anteriorly, head white in eye region; in 95% ethanol eye region lacking colour, gray-white head to pereonite 6, pereonite 7 to pleotelson light brown.

Head (fig. 43B) length subequal to width in dorsal view; width 0.85 pereonite 1 width; surface smooth and shiny (with scattered cuticular combs), dorsal setae sparse.

Pereon narrow, width near head width (1.18 head width); smooth. Typhlosole minimal, ventral

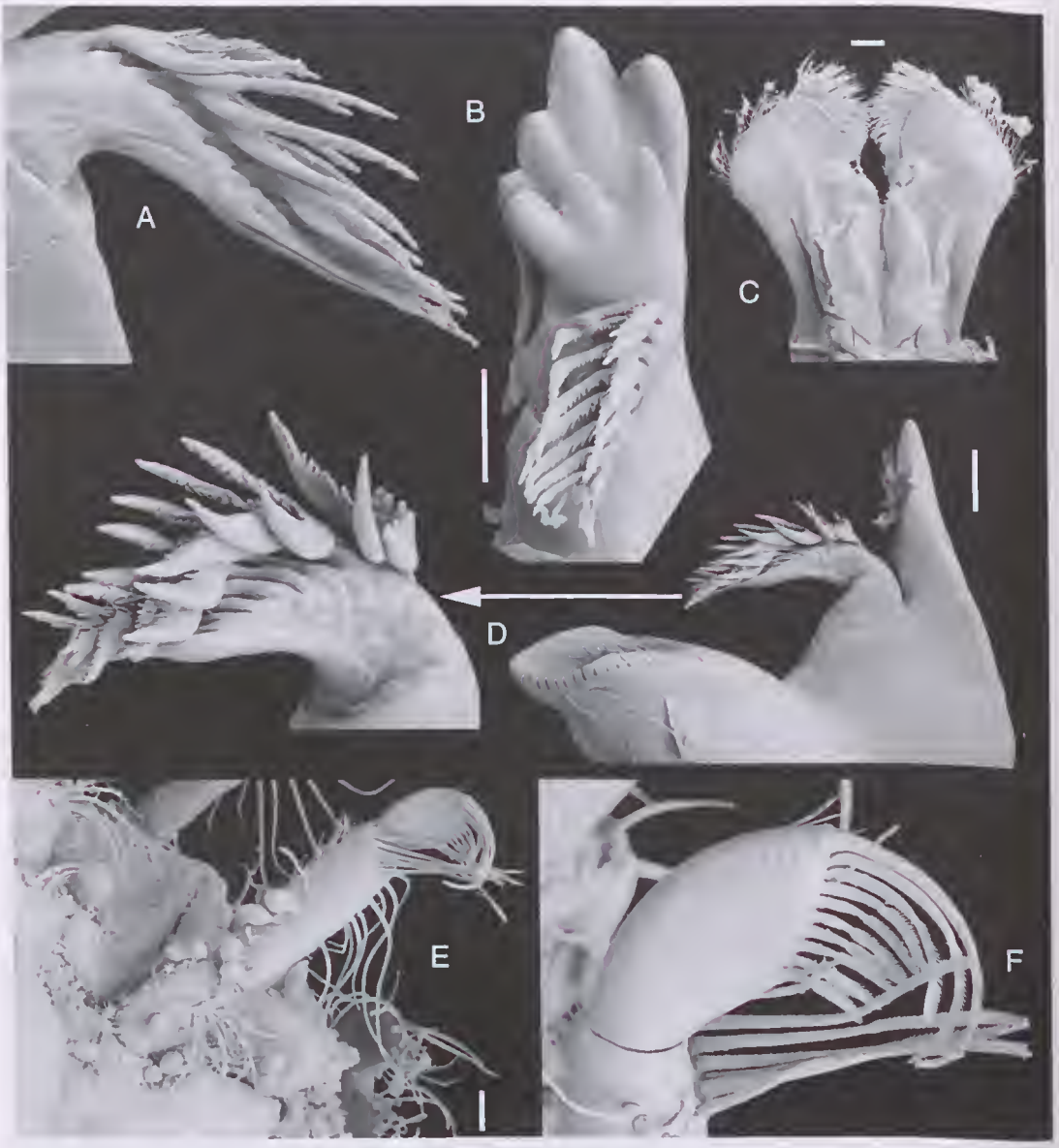

Figure 44. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61429), paratype female (AM P61428). A–B, male left mandible. C, male paragnaths. D, male right mandible. E–F, female right mandible palp. Scale bar 0.05 mm.

invagination forming laminar projection in cross section.

Pleonites in dorsal view 2–3 respective lengths less than half length of pleonite 5, *pleonite* 4 length more than half length of pleonite 5; *pleonites* 1–4 relative lengths unequal, increasing in length from anterior to posterior, width 0.88 composite length in dorsal view.

Pleotelson (figs 49A–D, G) lateral length 0.13 body length, 0.93 depth; dorsal length 1.3 width; depth 1.47 pereonite 7 depth. Dorsal surface with abundant long setae. Medial lobe width 0.27 pleotelson width, greatest length 0.04 pleotelson total length. Lateral lobes medial length 0.04 pleotelson total length, without robust sensillate setae. Ventral margin anterior to uropods with 4–6 denticulate and smooth setae (posterior seta smooth, anterior setae weakly denticulate), posterior seta smaller than anterior adjacent setae (thicker but shorter).

Figure 45. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61429). A, maxillula. B–C, maxilla. D–E, maxilliped. Scale bar 0.2 mm.

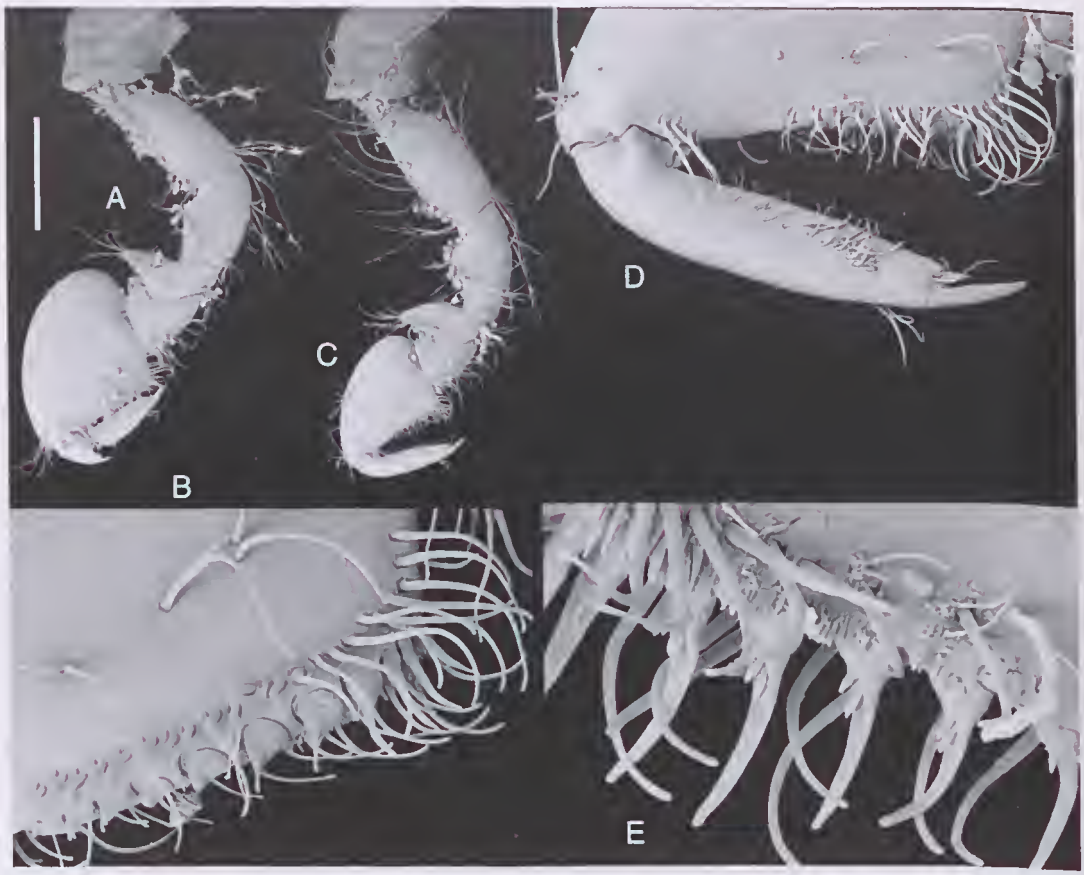

Figure 46. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61427) A, paratype female (AM P61428), paratype male (AM P61429) B. A, B, male pereopod 1. C–E, female pereopod 1. Scale bar 0.5 mm.

Antennula (figs 43E–F) length 0.11 body length, with 6 articles. Single tiny aesthetase on article 5 to terminal article. *Antenna* (figs 43B–D) length 0.34 body length. Flagellum length 0.57 total antenna length, with 16 articles.

Mouthfield clypeus broader medially, width 0.65 head width. *Mandible* (fig. 44) palp length 0.8 mandible length; article 3 with 11 setae; separate distal group of setae present; articles 1–2 with elongate setal row. Left spine row with 7–8 bifurcate spines, without additional spines between pedunculate projection and molar. Right spine row with 8 bifurcate spines, without additional spines between pedunculate projection and molar. Molar process setulate spines forming posterior row (2 tiny on right). *Maxillula* (fig. 45A) medial lobe length 0.86 lateral lobe length; width 0.67 lateral lobe width. Lateral lobe distal margin with 5 denticulate robust setae, 7 smooth robust setae. *Maxilla* (figs 45B–C) medial lobe width 0.56 outer lateral lobe width. *Maxilliped* (figs 45D–E) endite with 2 receptaculi on right side; dorsal ridge with 12 large distally denticulate plumose setae. Palp insertion on basis ventral surface without subdistal smooth setae.

Pereopod I (figs 46A–B) dactylus length 1.07 palm length. Propodus dorsal margin setae confined to single group at distal margin. Propodal palm convex to straight; stout denticulate setae absent; with 4 basally inflated stout robust simple setae; with 3 elongate broad based setae. Basis ventrodistal margin with 7 elongate setae. *Pereopod* IV (figs 47B–C) dactylus length subequal to propodal palm. Propodus with 3 broad based setae on ventral margin, none distinctly larger than others; articular plate shorter than dactylar claw. *Pereopods* V–VII (fig. 47E) basis dorsal ridge in cross section angular.

Penes (fig. 47F) length 0.26 body width at pereonite 7, distally tubular.

Pleopod (figs 48, 47G, 49H) I exopod distal margin rounded; medial margin concave from proximal to distal half, subparallel to lateral margin; dorsal surface lacking setae. *Pleopod* II endopod appendix masculina length 0.59 pleopod length.

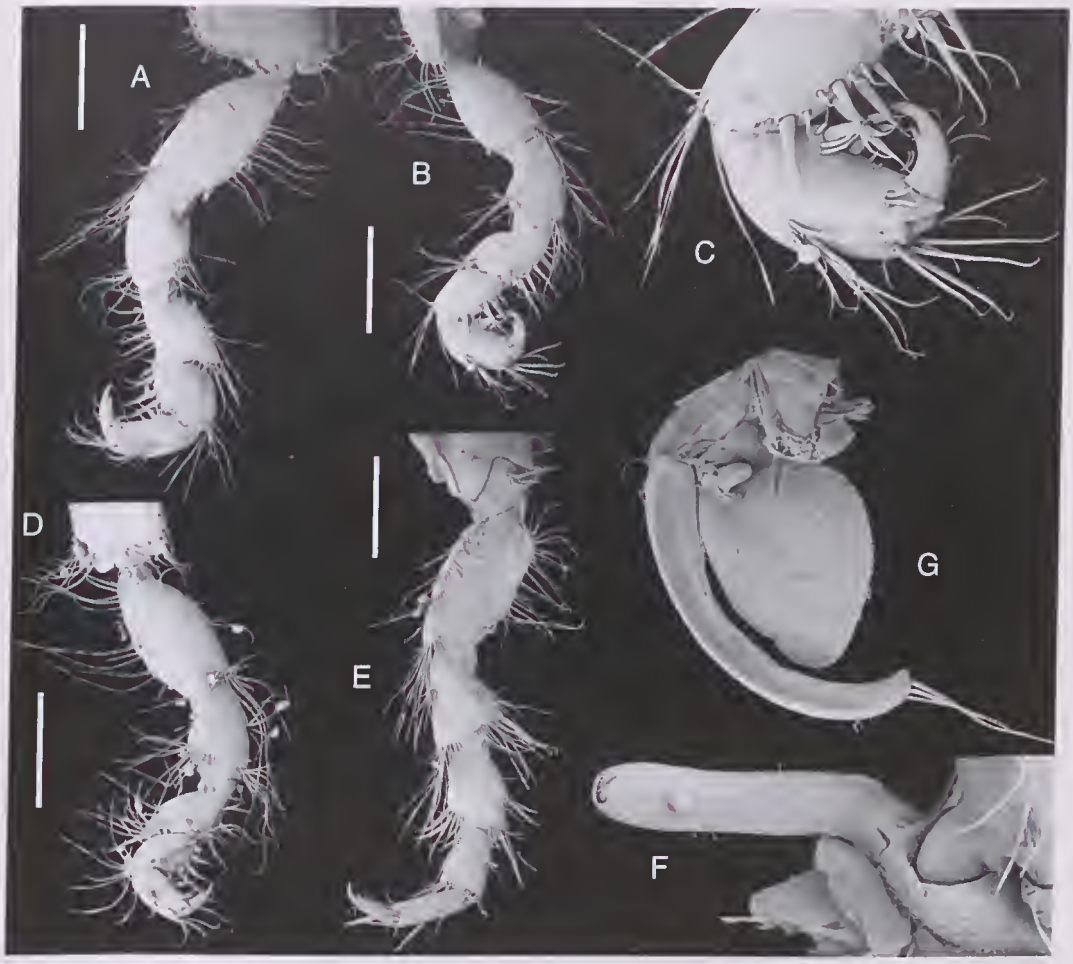

Figure 47. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61429), paratype female (AM P61428). A, male pereopod II. B–C, male pereopod IV. D, female pereopod IV. E–F, male pereopod VII, including proximal articles, with penes. G, male pleopod II appendix masculina and endopod. Scale bar 0.5 mm.

Uropod (figs 49C–D, F–G) total length 1.04 pleotelson length. Protopod length 0.36 uropod total length; dorsomedial margin in dorsal view strongly concave laterally, margin setae absent. Exopod length 0.63 endopod length.

Sexual dimorphism, female differences. Antenna length 0.31 body length, flagellum length 0.63 total antenna length, with 17 articles. *Pereopod* I (figs 46C–E) daetylus length 1.13 palm length; propodal palm with 5 stout denticulate serrate setae, 2 stout robust conical simple setae and 3 elongate broad based setae. *Uropod* length 1.06 pleotelson length, protopod length 0.44 uropod total length, exopod length 0.8 endopod length.

Distribution. Stony Creek, above and below Turret Falls, Grampians National Park.

Remarks. Gariwerdeus turretensis sp. nov. is easily distinguished from other species in the genus and from *Naiopegia xiphagrostis* sp. nov. by the enlarged male pereopod I propodus, much larger than males of the other species where the first pereopods of males resemble those of females. A short, almost truncate pleotelson with a highly abbreviated medial lobe that lacks robust setae, and an inflated article 6 on the antennula, also serve to identify this species.

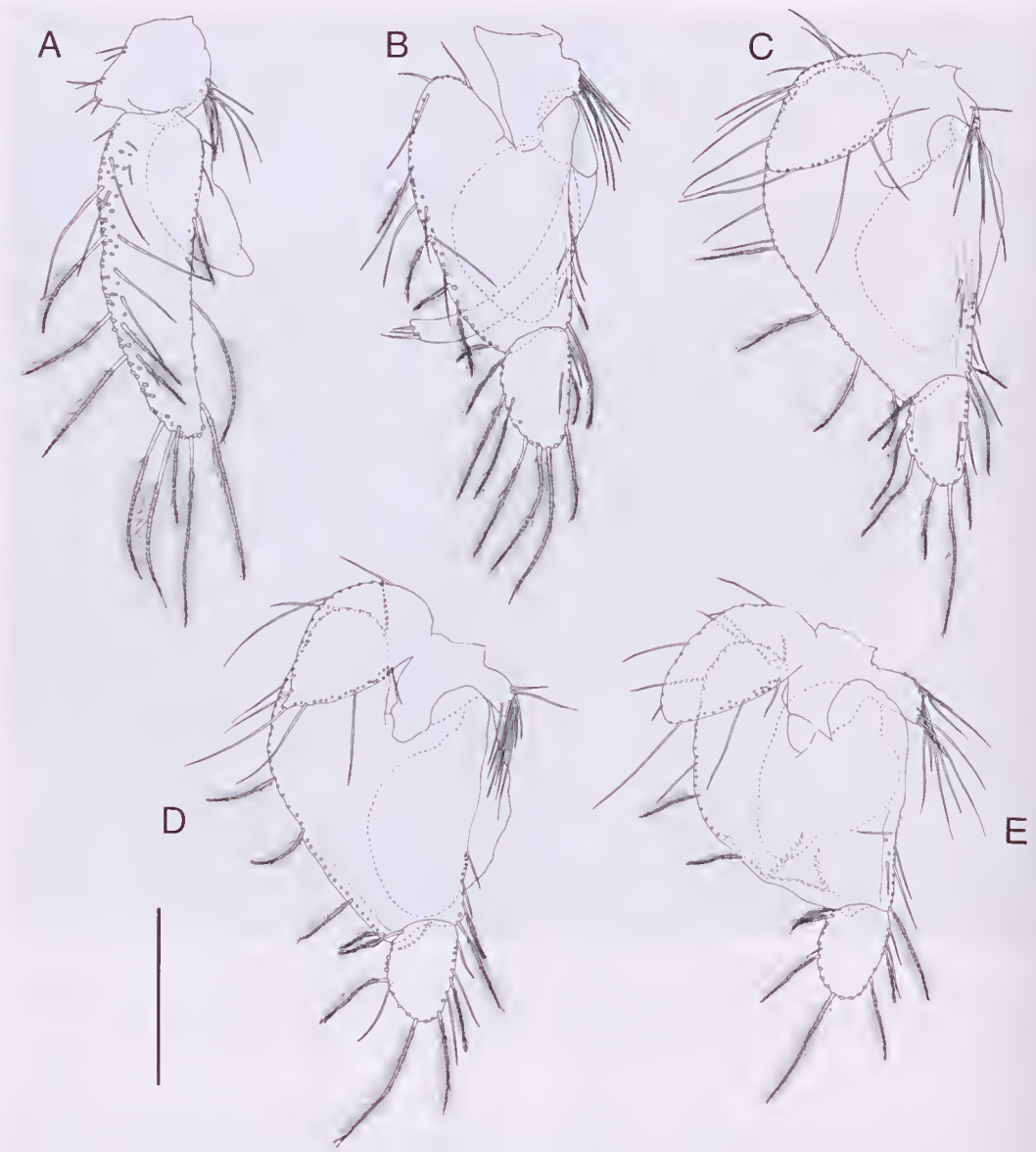

Figure 48. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61427). A–E, pleopods I–V. Scale bar 0.5 mm.

Gariwerdeus beehiveusis sp. nov.

Figures 50–57

Material examined. Holotype. Victoria, among roots of treefern at the base of Beehive Falls, Mud Hut Creek, near Roses Gap, Grampians National Park, 36°58.54′S 142°27.01′E (GPS), hand sieves, pH 4.6, 10.3°C, G. Wilson, R. Wetzer and S. Keable, 22 Sep 1999, VIC-97, NMV J40735 (male bl 7.3 mm).

Paratypes. All lots collection details as for holotype. AM P61276 (39 ind., including male bl 7.8 mm, female bl 5.4 mm used to supplement description), AM P61430 (male bl 8.7 mm, dissected for illustration, SEM and description), AM P61431 (female bl 5.9 mm, dissected for SEM and description).

Other material. Series from Vic., Grampians, collected hand sieves, G. Wilson, R. Wetzer and S. Keable, Sep 1999, preserved in 95% ethanol – base of Fish

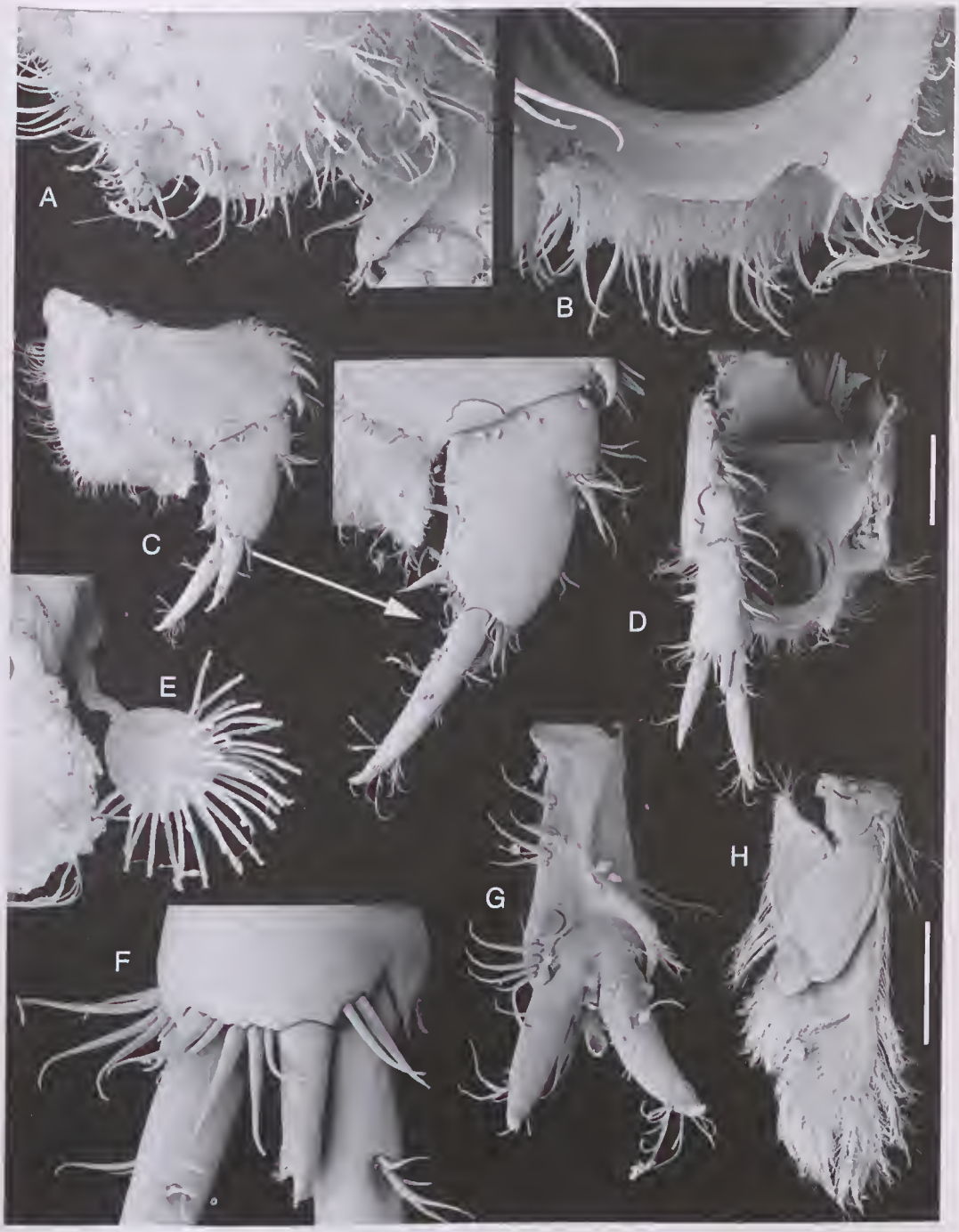

Figure 49. *Gariwerdeus turretensis* gen. nov., sp. nov. Paratype male (AM P61429), paratype female (AM P61428). A–D, G, male pleotelson and uropod, dorsal, ventral and lateral views. E, suctorian ciliate protozoan epibiont on male uropod. F, male uropod protopod distal margin, ventral view. H, female pleopod II. Scale bar 0.5 mm.

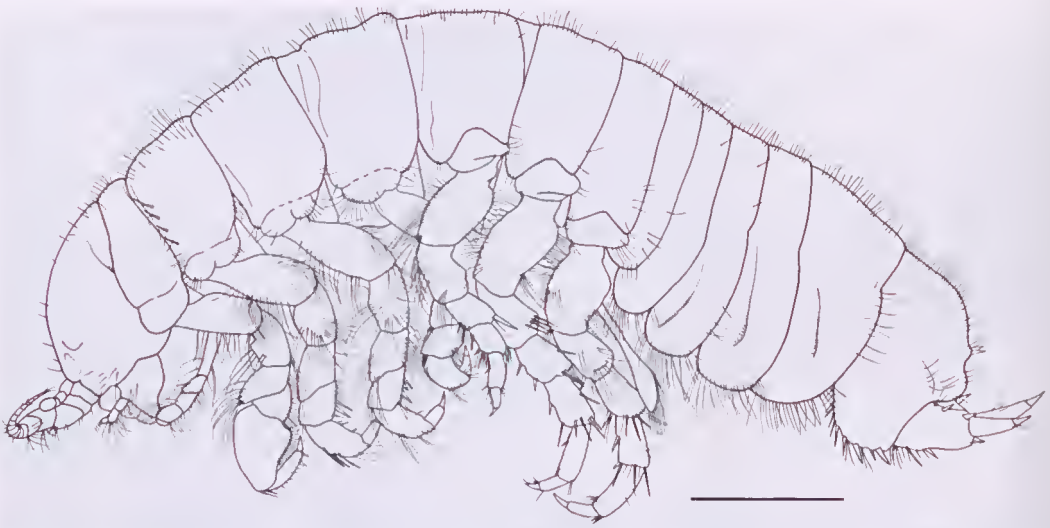

Figure 50. *Gariwerdeus beehivensis* gen. nov., sp. nov. Holotype male (NMV J40735), lateral view. Scale bar 1 mm.

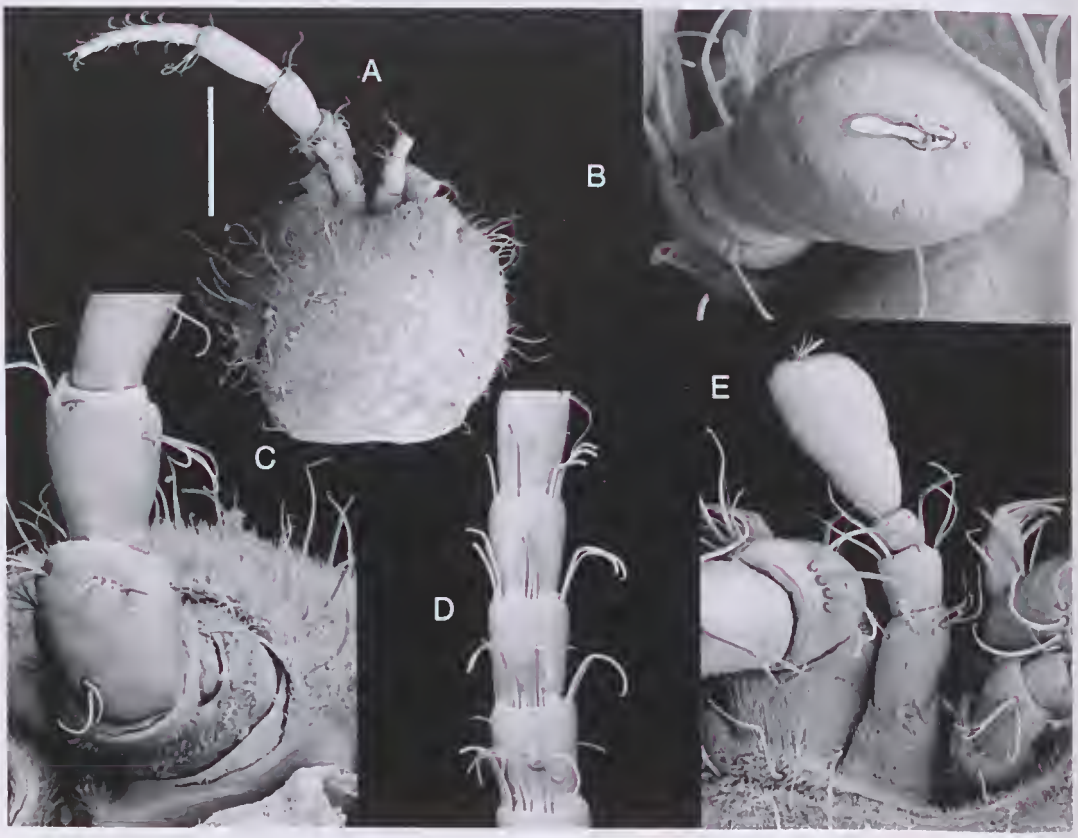

Figure 51. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430), paratype female (AM P61431). A, male head, dorsal view. B, female antennula distal articles. C, male antenna proximal artieles. D, male antenna flagellum articles. E, female antennula, dorsal view. Scale bar 0.5 mm.

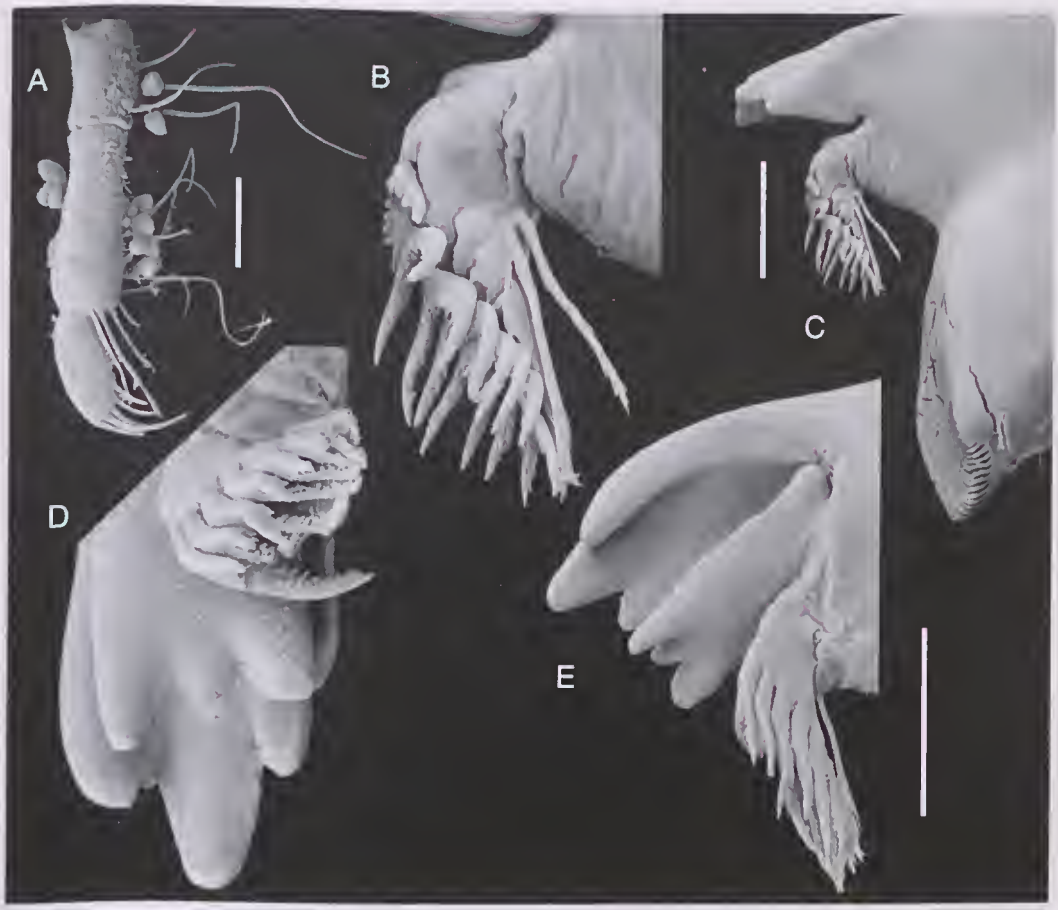

Figure 52. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430). A, D–E, left mandible. B–C, right mandible. Scale bar 0.1 mm.

Falls, Mackenzie R., 37°06.59′S 142°24.01′E (GPS), from reedy pool close to main falls, pH 6.6, 10.6°C, 20 Sep, VIC-86, AM P61277 (male, female); S side of Goulton Gorge, 36°55.89′S 142°25.09′E (GPS), gravel from roots of trees and grasses half way up steep water course, pH 6.7, 14.3°C, 22 Sep, VIC-98, AM P61278 (30 ind.); Goulton Creek on west side of Pohlner Road, 36°58.35′S 142°24.83′E (GPS), roots and sediment, pH 6.1, 17.1°C, 22 Sep, VIC-99, AM P61279 (18 ind.) and NMV J40736 (male, 2 females).

Etymology. This species name is derived from the type locality, Beehive Falls (on Mud Hut Creek) in The Grampians National Park.

Diagnosis. Pleotelson medial lobe with 2 robust smooth setae and several small simple setae. *Antennula* terminal segment inflated and bulbous; article 5 distal articulation rudimentary, length less than article 6 length, lacking aesthetasc. *Mandible* right lacinia mobilis with 1 row of denticles. *Pereopod* I of male dactylus ventrodistal margin with row of thin scale-like spines; propodus dorsal margin not produced proximally; propodal palm cuticular fringe strongly developed, extending along length of setal row. *Pereopods* II–IV basis dorsal margin elongate setae in row, not clustered. *Pleopod* II endopod appendix masculina distal tip broadly rounded, with 3 setae on margin. *Uropod* distoventral margin with 2 robust distally spinose setae, simple setae absent.

Description based on male. Coloration in life brown mottled (although brown colour mostly appears to be fine sediment) with white head, white patch in eye region.

Head (fig. 51A) length subequal to width in dorsal view; width 0.83 pereonite 1 width; dorsal surface with dense cuticular hairs, setae sparse.

Figure 53. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430). A, paragnaths. B–C, maxillula. D–E, maxilla. F–G, maxilliped. Scale bar 0.2 mm.

Pereon broad, smooth, width exceeding head width (1.55 head width). Typhlosole minimal, ventral invagination forming inverted 'u' shape in cross section.

Pleonites 2 length less than half length of 5 in dorsal view, 3–4 respective lengths more than half length of 5; 1–4 relative lengths unequal, increasing in length from anterior to posterior, width 1.44 composite length in dorsal view.

Pleotelson (figs 57A–D) lateral length 0.1 body length, 0.61 depth; dorsal length 1.03 width; depth 1.38 pereonite 7 depth. Dorsal surface with abundant long setae. Medial lobe width 0.33 pleotelson width, greatest length 0.07 pleotelson total length. Lateral lobes medial length 0.1 pleotelson total length. Ventral margin anterior to uropods with 5–9 dentieulate setae (anterior 5 setae large and robust, posterior 4 less robust, interspersed with fine setae), posterior seta subequal to anterior adjacent setae.

Antennula (figs 51B, E) length 0.07 body length, with 6 articles, 1–2 tiny aesthetases on terminal article. *Antenna* (figs 51A, D) length 0.21 body length. Flagellum length 0.57 total antenna length, with 12 articles.

Mouthfield clypeus broader on left side, width 0.44 head width. *Mandible* (fig. 52) palp length 0.64 mandible length; article 3 with 6 setae; separate distal group of setae present; articles 1–2 with elongate setal row. Right incisor process with 3 cusps. Left spine row with 8 spines, 6 bifurcate, total count includes 2 on margin between pedunculate projection and molar. Right spine row with 10 spines, 8 bifurcate, total count including 2 on margin between pedunculate projection and molar. Molar process length subequal to width;

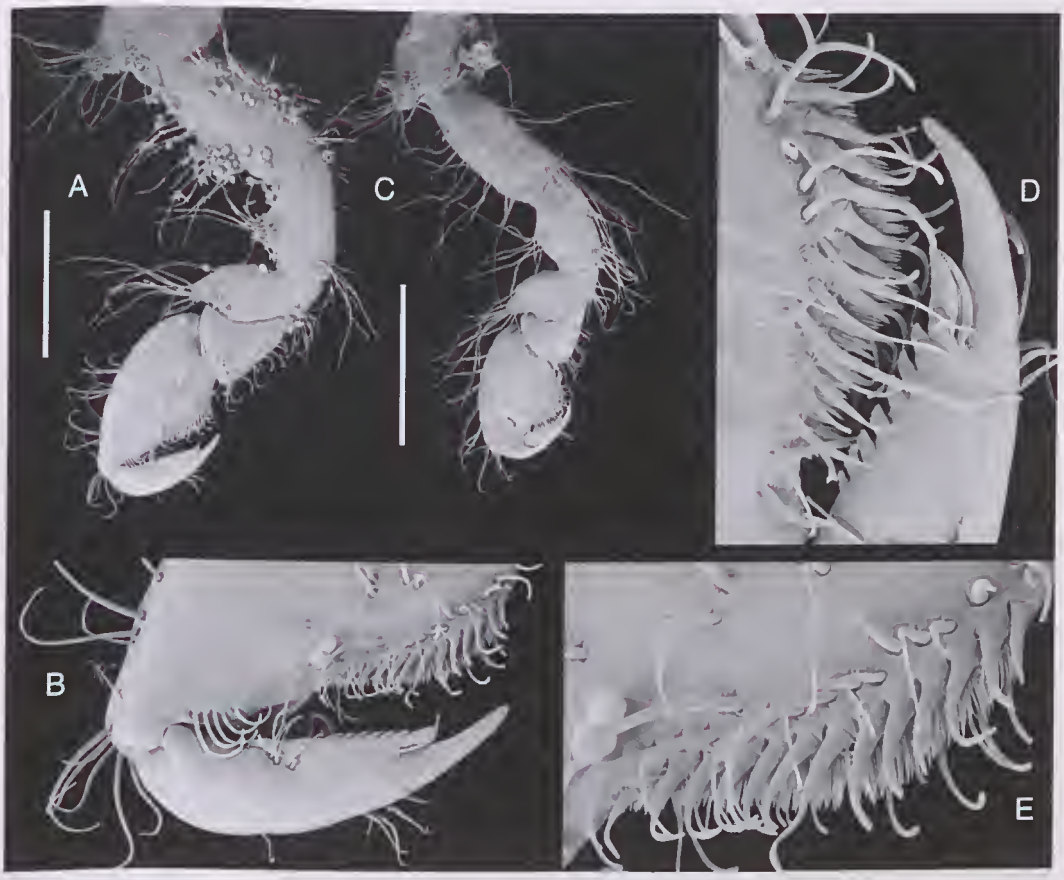

Figure 54. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430), paratype female (AM P61431). A–B, E, male pereopod 1. C–D, female pereopod 1. Scale bar 0.5 mm.

complex setulate spines forming posterior row (left) or ciliated spines forming posterior row (right, 2). *Maxillula* (figs 53B–C) medial lobe length 0.82 lateral lobe length; width 0.73 lateral lobe width. Lateral lobe distal margin with 3 denticulate robust setae, 9 smooth robust setae. *Maxilla* (figs 53D–E) medial lobe width 1.0 outer lateral lobe width. *Maxilliped* (figs 53F–G) endite with 3 receptaculi on right side; dorsal ridge with 10 large distally denticulate plumose setae. Palp insertion on basis ventral surface with 1 subdistal smooth seta.

Pereopod 1 (figs 54A–B, E) dactylus length subequal to palm, length 1.03 palm length; ventrodistal margin thin scale-like spines along 0.28 total length of margin. Propodus dorsal margin with 10 setae in several groups between proximal and distal margin (excluding distal group). Propodal palm sinuate; cuticular fringe weakly developed; stout denticulate setae absent; with 12 stout robust simple conical setae; elongate broad based setae absent. Basis ventrodistal margin with 9 elongate setae in male. *Pereopod* IV (figs 55B–C) dactylus length subequal to propodal palm; distal accessory claw-spines absent. Propodus with 5 broad based setae on ventral margin, 3 distinctly larger than others; articular plate shorter than dactylar claw. *Pereopods* V–VII (fig. 55E) basis dorsal ridge in cross section rounded on pereopod V, angular on pereopods VI–VII.

Penes (fig. 55F) length 0.33 body width at pereonite 7, distally tapering.

Pleopod (figs 56, 57G–I) 1 exopod distal margin pointed, medial margin sinuate – divergent from lateral margin along most of length, dorsal surface with setae. *Pleopod* II endopod appendix masculina length 0.55 pleopod length.

Uropod (figs 57D–F) total length 1.11 pleotelson length. Protopod length 0.39 uropod total length; dorsomedial margin in dorsal view parallel to lateral margin, margin setae present distally. Exopod length 0.68 endopod length.

Sexual dimorphism, female differences. Antenna length 0.25 body length. Flagellum length 0.52 total antenna length, with 11 articles. *Pereopod* 1 (figs 54C–D) dactylus length 0.93 palm length, ventrodistal margin with 6 narrow scale-like spines, along 0.37 total length;

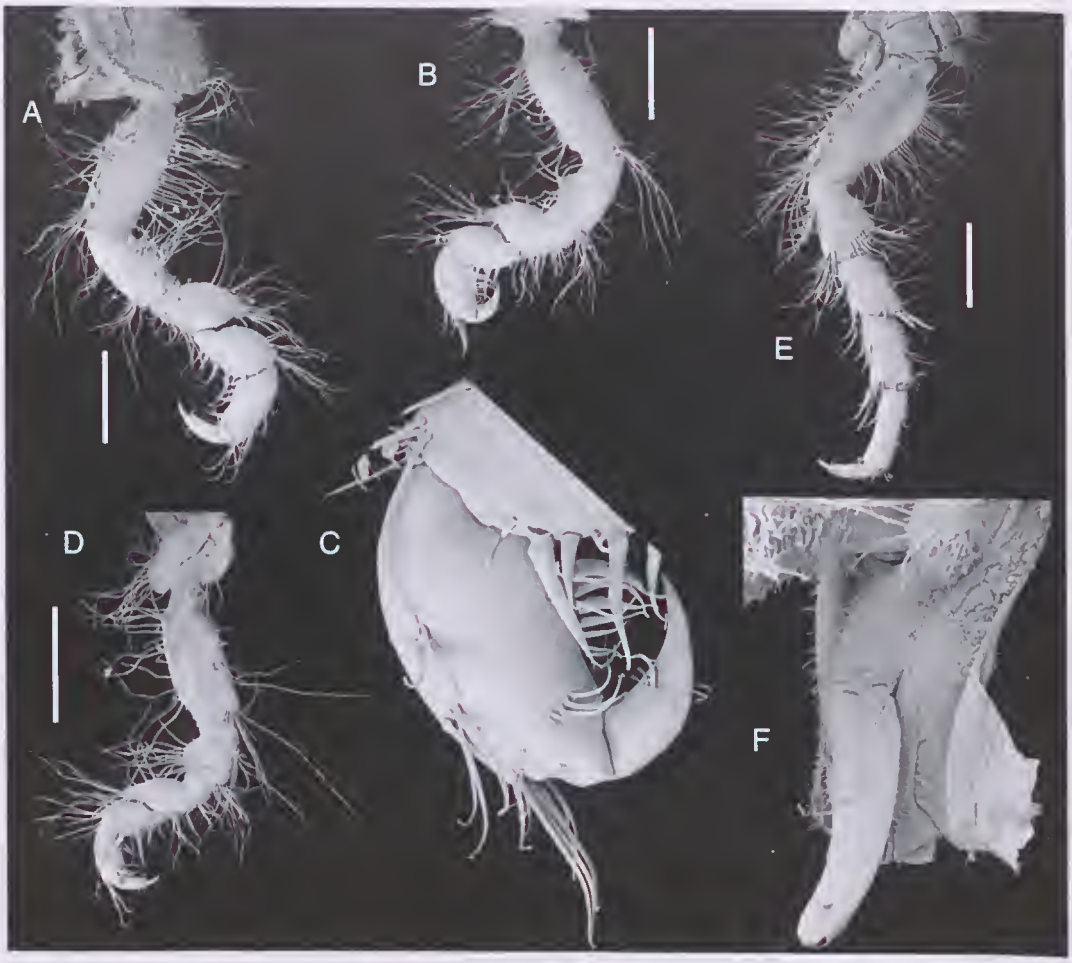

Figure 55. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430), paratype female (AM P61431). A, male pereopod II. B–C, male pereopod IV. D, female pereopod IV. E–F, male pereopod VII, including proximal articles, with penes. Scale bar 0.5 mm.

propodal palm with 9 stout robust conical simple setae; basis ventrodistal margin with 7 elongate setae. *Uropod* protopod length 0.46 uropod total length; exopod length 0.83 endopod length.

Distribution. Beehive Falls, Mud Hut and Goulton Creek drainages and Fish Falls (Mackenzie R.), Grampians National Park.

Remarks. Several characters distinguish *Gariwerdeus beehivensis* sp. nov. from other species of the genus: the 2 inflated distal antennular segments have only a rudimentary articulation with article 5 lacking aesthetascs, the head is rugose with many fine cuticular hairs, and the medial lobe of the pleotelson has 2–4 robust setae.

The specimens from Goulton Gorge and Goulton Creek (AM P61278–9) contains larger specimens than found in the types (males reaching a length of 11.8 mm versus 8.7 mm in type material). These larger specimens have more prominent medial and lateral lobes on the pleotelson, and have more robust setae on the medial lobe (4 versus 2). The same samples, however, have specimens of similar size to, and indistinguishable from, the type material. The male and female specimens from Fish Falls (AM P61277) are of similar size to the type material and have similar posterior pleotelson lobes; the male from this sample has four robust setae on the medial lobe and the female has three.

Figure 56. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430). A–E, pleopods I–V. Scale bar 0.5 mm.

Gariwerdeus ingletonensis sp. nov.

Figures 58–65

Material examined. Holotype. Vic., Ingleton Spring at picnic ground off Syphon Road, Grampians National Park, 37°18.17′S 142°22.01′E (GPS), in white sand at point where spring flows from under a rock, hand sieves, pH 4.7, 12.7°C, G. Wilson, R. Wetzer and S. Keable, 21 Sep 1999, VIC-94, NMV J40737 (male bl 7.2 mm).

Paratypes. All lots collection details as for holotype. AM P61280 (26 ind., including female bl 6.6 mm used to supplement description), AM P61432 (male bl 8.3 mm, dissected for SEM and description), AM P61433 (female bl 6.7 mm, dissected for SEM and description), AM P61444 (male bl 7.9 mm, dissected for pleopod illustrations), NMV J40738 (male, female, juvenile female).

Etymology. As in other species of *Gariwerdeus*,

Figure 57. *Gariwerdeus beehivensis* gen. nov., sp. nov. Paratype male (AM P61430), paratype female (AM P61431). A–D, male pleotelson and uropod, dorsal and lateral views. E, male uropod lateral view. F, male uropod protopod distal margin, ventral view. G, female pleopod I. H, male pleopod I. I, male pleopod II appendix masculina and endopod. Scale bar 0.25 mm.

this species is named after the type locality, Ingleton Spring, The Grampians National Park, in this case.

Diagnosis. Pleotelson medial lobe robust sensillate setae absent (but with 6 fine simple setae). *Antennula* with 5 free articles, articles 5 and 6 inflated, each with 1 aesthetasc, terminal segment with unexpressed articulation. *Mandible* right lacinia mobilis with 2 rows of denticles. *Pereopod* I dactylus ventrodistal margin with thin

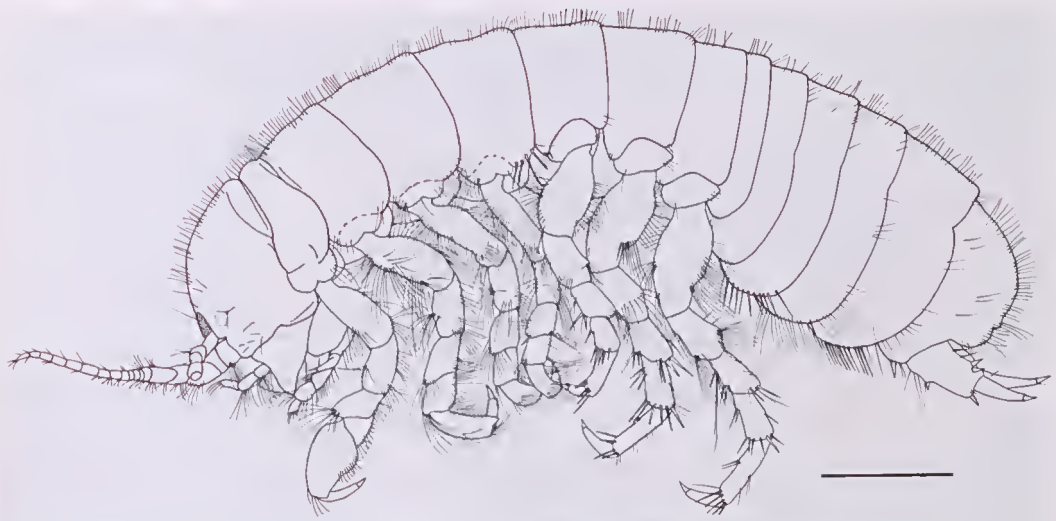

Figure 58. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Holotype male (NMV J40737), lateral view. Scale bar 1 mm.

truncate spines; propodus dorsal margin not produced proximally, palm cuticular fringe weakly developed. *Pereopods* II–IV basis dorsal margin elongate setae divided into proximal and distal cluster. *Pleopod* II endopod appendix masculina distal tip truncate, with 6 setae on margin. *Uropod* protopod distoventral margin with 2 robust distally spinose setae and 2 robust simple setae.

Description based on male. Coloration in life creamy white, head with bright white patch in eye region; in 95% ethanol, cream with lighter white patch in eye region.

Head (fig. 59D) length shorter than width in dorsal view; width 0.82 pereonite 1 width; surface with dense cuticular hairs and scattered setae.

Pereon broad, width exceeding head width (1.32 head width); smooth. Typhlosole minimal, ventral invagination forming laminar projection in cross section.

Pleonites 2–4 respective lengths more than half length of pleonite 5 in dorsal view; *pleonites* 1–4 relative lengths unequal, increasing in length from anterior to posterior, width 0.84 composite length in dorsal view.

Pleotelson (figs 65A–B) lateral length 0.11 body length, 0.7 depth; dorsal length 1.06 width; depth 1.5 pereonite 7 depth. Dorsal surface with abundant long setae. Medial lobe width 0.35 pleotelson width, greatest length 0.06 pleotelson total length. Lateral lobes medial length 0.14 pleotelson total length; lateral lobes robust sensillate setae absent. Ventral margin anterior to uropods with 5 denticulate and smooth setae (posterior setae weakly denticulate), posterior seta subequal to anterior adjacent setae (length subequal posterior seta slightly thicker).

Antennula (figs 59E–H) length 0.1 body length, with 5 articles, 2 tiny aesthetases on terminal article. *Antenna* (figs 59A–B) length 0.32 body length. Flagellum length 0.61 total antenna length, with 14–15 articles.

Mouthfield clypeus projecting anteriorly in medial region, width 0.48 head width. *Mandible* (fig. 60) palp length 0.64 mandible length; article 3 with 6 setae; articles 1–2 with elongate setal row. Left spine row with 11 spines, 8 bifurcate, total count including 3 on margin between peduncular projection and molar. Right spine row with 15 spines, 9 bifurcate, including 6 on margin between peduncular projection and molar. Molar process length subequal to width; complex setulate spines forming posterior row (both sides). *Maxillula* (figs 61B–D) medial lobe length 0.85 lateral lobe length; width 0.73 lateral lobe width. Lateral lobe distal margin with 4 denticulate robust setae, 8 smooth robust setae. *Maxilla* (figs 61E–F) medial lobe width 0.8 outer lateral lobe width. *Maxilliped* (figs 61G–H) endite with 4 receptaculi on right side; dorsal ridge with 13 large distally denticulate plumose setae. Palp insertion on basis ventral surface with 9 subdistal smooth setae (forming row).

Pereopod 1 (fig. 62A) dactylus length subequal to palm; ventrodistal margin thin denticulate spines along 0.51 total length. Propodus dorsal margin with 5 setae in several groups between proximal and distal margin (excluding distal group). Propodal palm concave, with 6 stout serrate setae and 4 elongate broad based setae. Basis ventrodistal proximal margin with 8–14 elongate setae. *Pereapod* IV (fig. 63B) dactylus length subequal to propodal palm. Propodus with 4 broad based setae on ventral margin, 1 distinctly larger than others; articular plate longer than dactylar claw. *Pereopods* V–VII (fig. 63C) basis dorsal ridge in cross section angular.

Figure 59. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype female (AM P61433), paratype male (AM P61432). A–B, female antennula and antenna. C–D, male head, antennula and antenna, dorsal view. E–F, male antennula distal articles. G, female antennula, dorsal view. H, female antennula distal articles. Scale bar 0.5 mm.

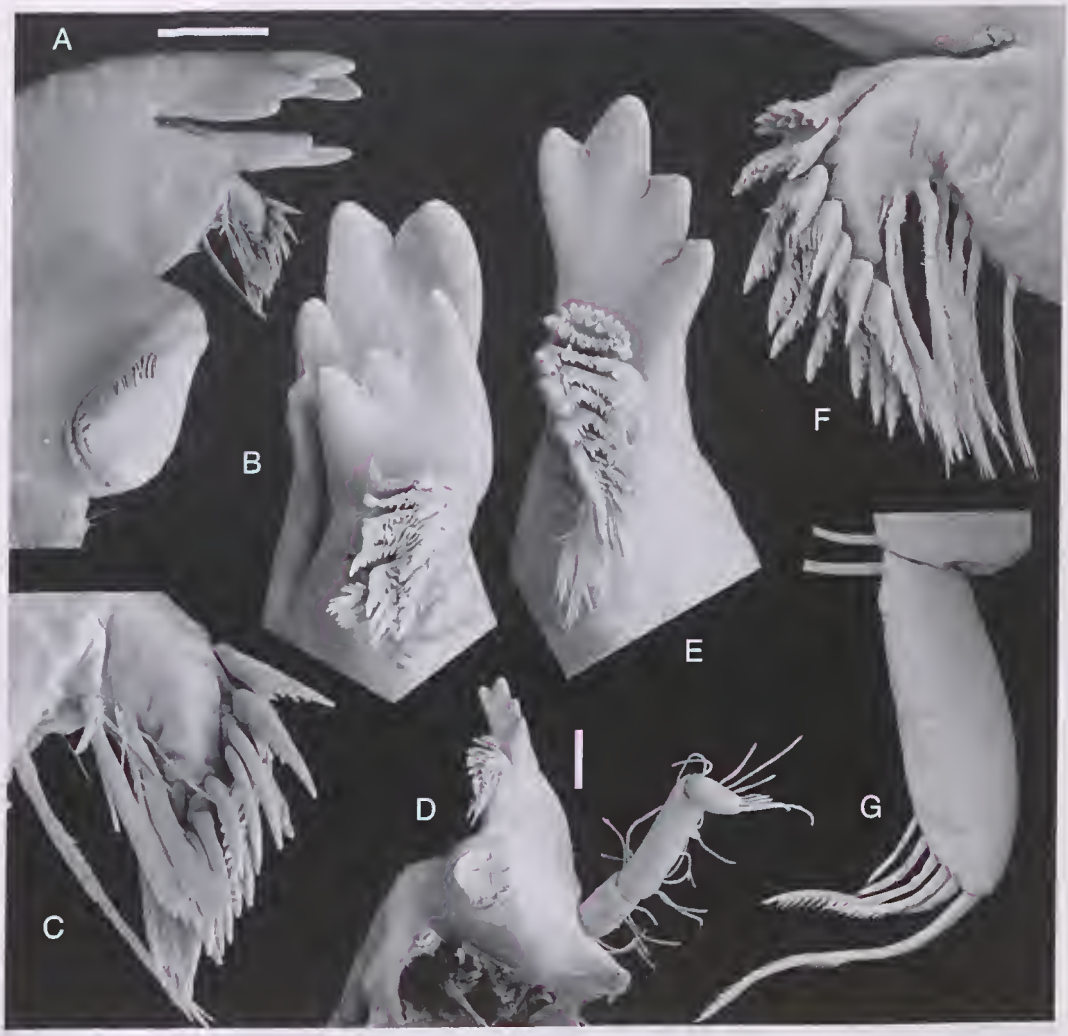

Figure 60. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61432). A–C, G, left mandible. D–F, right mandible. Scale bar 0.1 mm.

Penes (fig. 63F) length 0.19 body width at pereonite 7, distally tapering.

Pleopod I (figs 64, 63D–E) exopod distal margin rounded, medial margin concave from proximal to distal half, subparallel to lateral margin, dorsal surface lacking setae. *Pleopod* II endopod appendix maseulina length 0.54 pleopod length.

Uropod (figs 65A, C–D) total length 1.22 pleotelson length. Protopod length 0.46 uropod total length; dorsomedial margin in dorsal view concave laterally, margin setae present distally. Exopod length 0.8 endopod length.

Sexual dimorphism, female differences. Antenna flagellum length 0.63 total antenna length, with 12–14 artieles. Pereopod I (figs 62B–D) dactylus ventrodistal margin with 8 hroad eutieular fringe spines. *Pereopod IV* propodus with I broad based seta on ventral margin. *Uropod* total length 1.1 pleotelson length; exopod length 0.89 endopod length.

Distribution. Ingleton Spring, Grampians National Park.

Remarks. An abbreviated antennule, eonsisting of only 5 segments, is the most distinetive feature of *Gariwerdeus ingletonensis* sp. nov. The inflated, distally expanding distal antennular segment is a composite of two segments with their articulation being unexpressed, but with two separate aesthetases present. This morphology is similar to

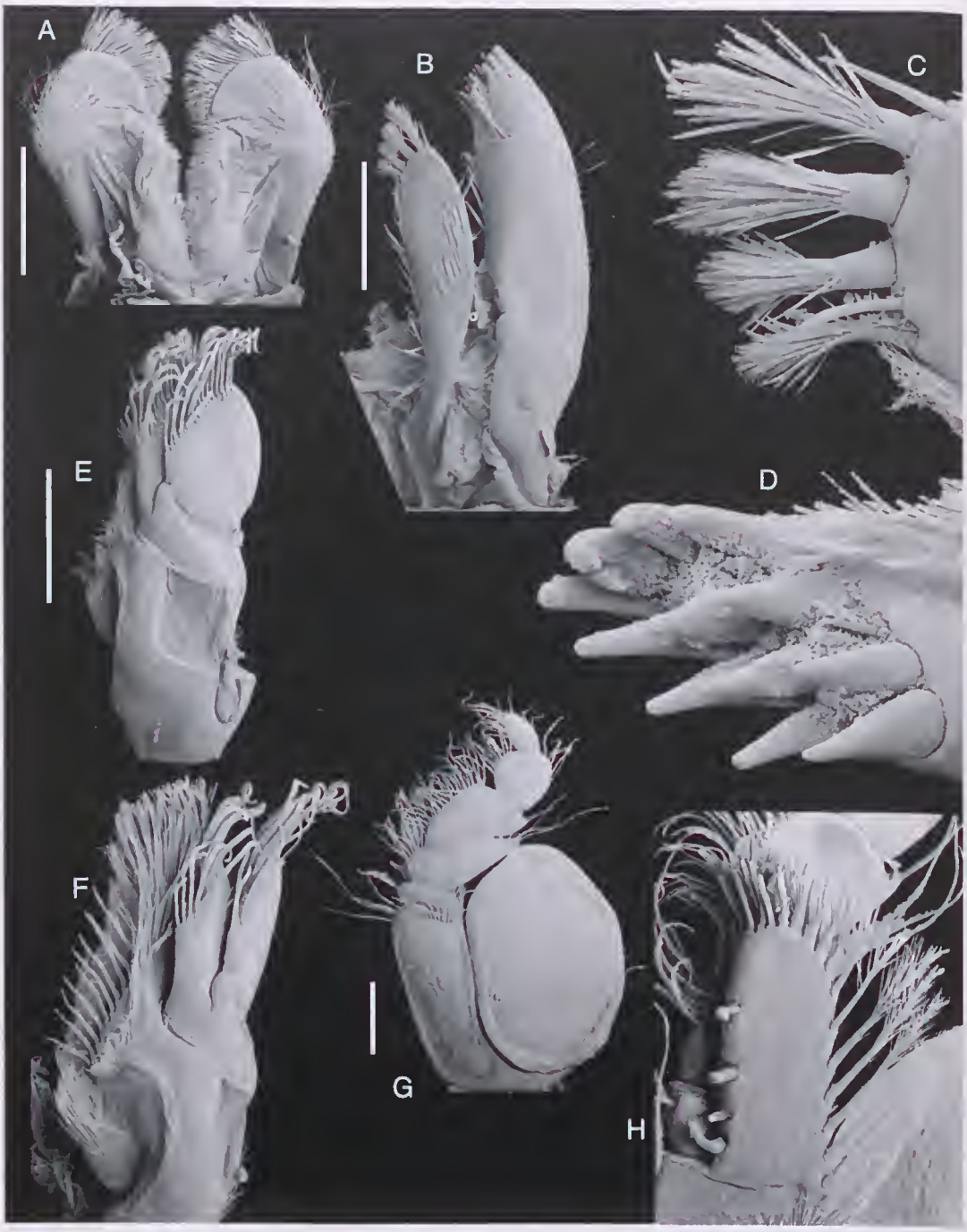

Figure 61. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61432). A, paragnaths. B–D, maxillula. E–F, maxilla. G–H, maxilliped. Scale bar 0.2 mm.

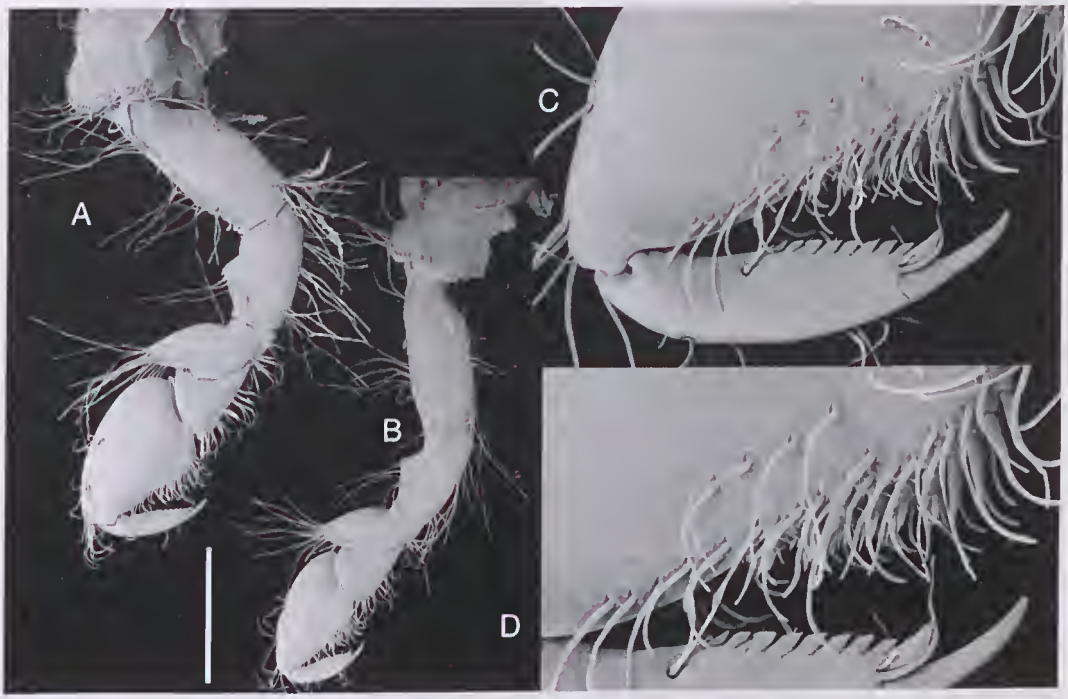

Figure 62. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61432), paratype female (AM P61433). A, male pereopod I. B–D, female pereopod I. Scale bar 0.5 mm.

that seen in amphisopodid species, where the terminal antennular segment is also composite. Of the two species of *Gariwerdeus* that lack robust setae on the medial lobe of the pleotelson, *G. ingletonensis* has a more rounded posterodorsal margin of the pleotelson in lateral view than *G. turretensis* where the pleotelson appears almost truncate in lateral view.

Acknowledgments

We thank the following people and institutions for their part in our research. Tim Doeg sent us specimens of *Synamphisopus* collected as part of a project conducted by the Flora and Fauna Branch, Department of the Natural Resources and Environment, Victoria. John Clamp advised us on protist epibionts. Regina Wetzer participated in the field trip wherein most specimens were collected, and is assessing DNA sequences from various phreatoicideans. Anna Cerra dried and mounted specimens and obtained the SEM images. Kate Dempsey prepared the plates, Sue Bullock inked some of our pencil drawings and Rick Johnson assisted with managing the DELTA database. Gary Poore and a referee for this journal provided useful suggestions for improvement of the manuscript. Gary also advised us of the correct publication date for the Spencer and Hall description of *Phreatoicopsis*. This research was supported a grant from the Australian Biological Resources Survey, and is a contribution of the Australian Museum Centre for Evolutionary Research.

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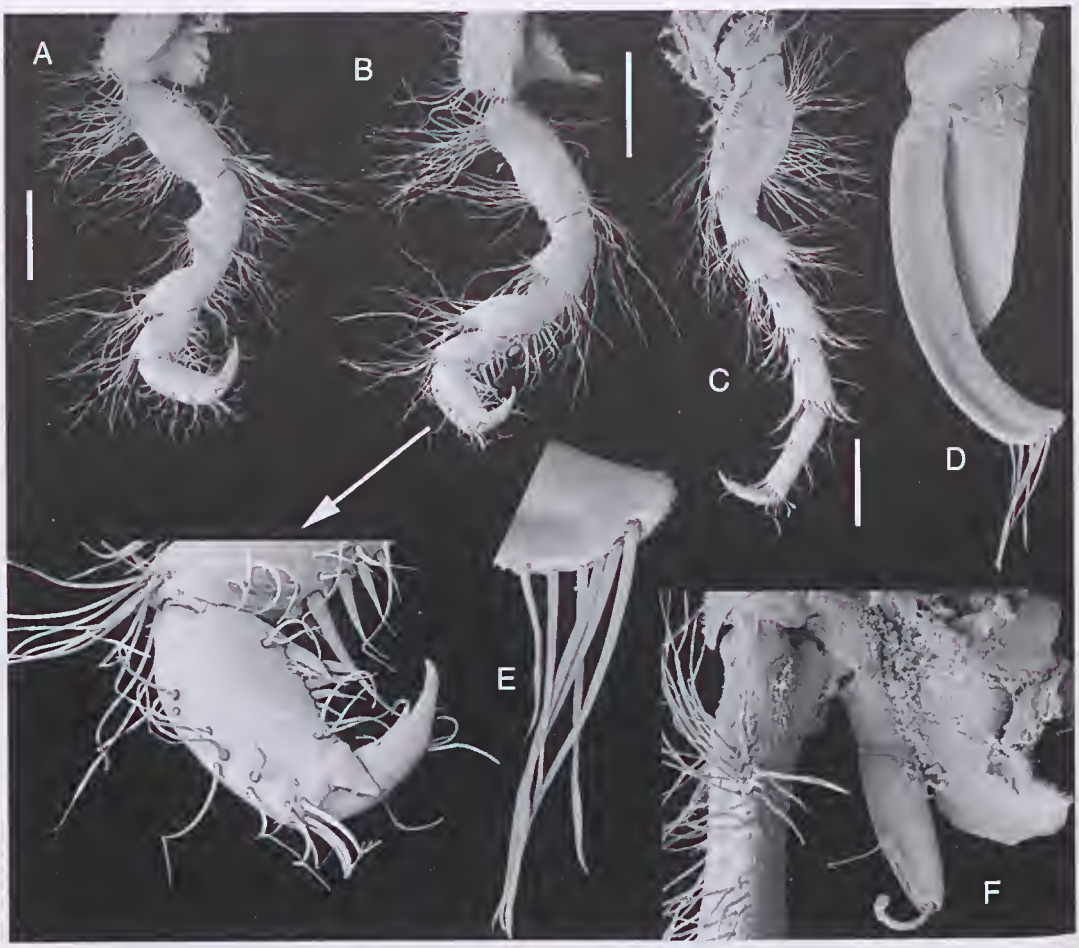

Figure 63. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61432). A, percopod II. B, pereopod IV. C, F, pereopod VII, including proximal articles, with penes. D–E, pleopod II appendix masculina. Scale bar 0.5 mm.

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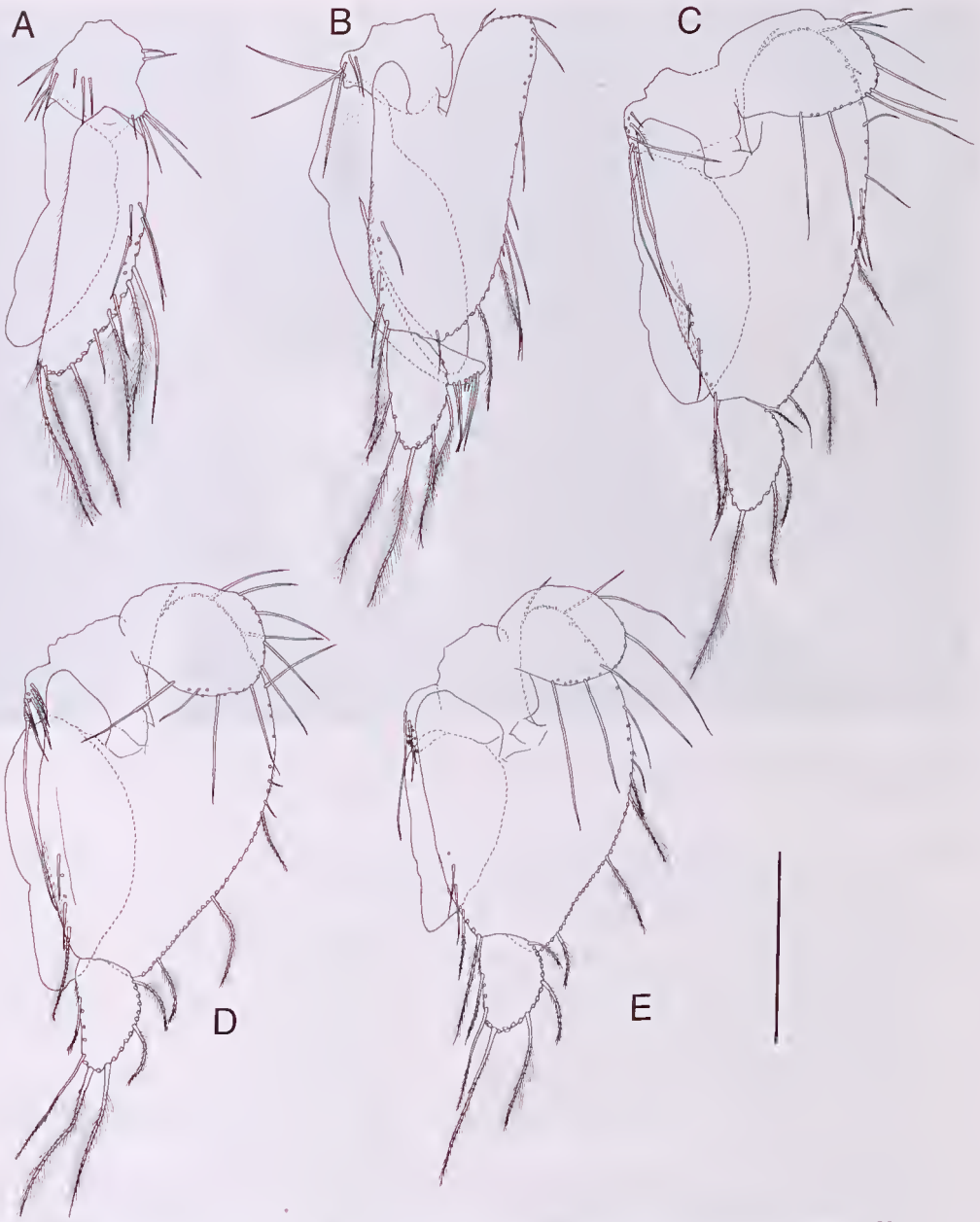

Figure 64. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61444). A–E, pleopods I–V. Scale bar 0.5 mm.

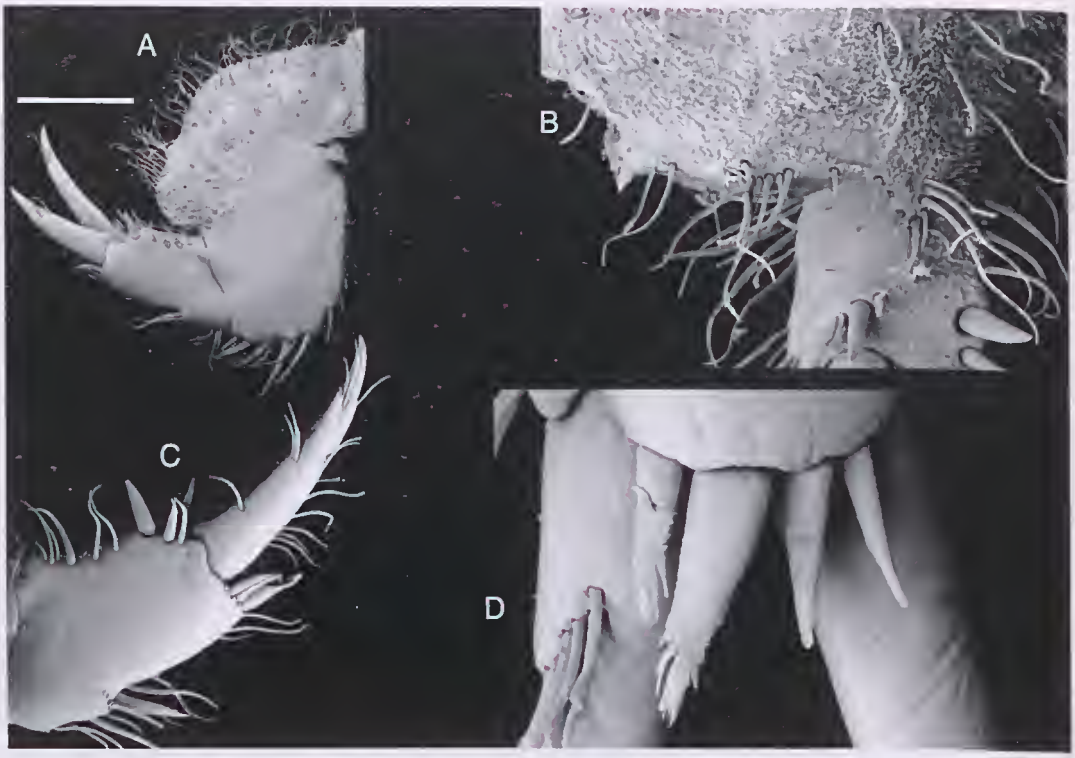

Figure 65. *Gariwerdeus ingletonensis* gen. nov., sp. nov. Paratype male (AM P61432). A–B, pleotelson and uropod, lateral and dorsal views. C, uropod, medial view. D, uropod protopod distal margin, ventral view. Scale bar 0.5 mm.

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Memoirs of the Museum of Victoria 59(2): 531–540 (2002)

REDESCRIPTIONS OF *ASPHALIDESMUS* LEAE SILVESTRI, 1910 AND *A. PARVUS* (CHAMBERLIN, 1920) COMB. NOV. FROM TASMANIA, AUSTRALIA (DIPLOPODA: POLYDESMIDA: HAPLODESMIDAE)

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Abstract

Mesibov, R., 2002. Redescriptions of *Asphalidesmus leae* Silvestri, 1910 and *A. parvus* (Chamberlin, 1920) comb. nov. from Tasmania. Australia (Diplopoda: Polydesmida: Haplodesmidae). *Memoirs of Museum Victoria* 59(2): 531–540.

Atopodesmus Chamberlin, 1920 is synonymised with *Asphalidesmus* Silvestri, 1910. *Asphalidesmus leae* Silvestri, 1910 and *A. parvus* (Chamberlin, 1920) comb. nov. are redescribed from abundant, recently collected material. The two millipede species appear to be endemic to Tasmania but have widely separated ranges.

Introduction

Early last century, Filippo Silvestri and Ralph Chamberlin independently described small Tasmanian polydesmoid millipedes with dense metatergal tuberculation and laterally expanded paranota on the second tergites. Each man established a monotypic genus for the material he examined: *Asphalidesmus* Silvestri, 1910 for a male specimen and *Atopodesmus* Chamberlin, 1920 for two females. Neither Silvestri nor Chamberlin assigned his genus to a family and the correct taxonomic placement of *Asphalidesmus* and *Atopodesmus* has long been a myriapodological puzzle.

Attems (1926) and Verhoeff (1932) placed *Asphalidesmus* in Fontariidae Attems, 1926, but Attems (1940) later regarded *Asphalidesmus* as a genus of uncertain status within Vanhoeffeniidae Attems, 1914.

Verhoeff (1932) ignored *Atopodesmus* entirely because it had been described in a work (Chamberlin, 1920) which lacked illustrations and was therefore unscientific: '…diese Arbeit [kann] weder berücksichtigt werden noch überhaupt als wissenschaftlich gelten' (Verhoeff, 1932: 1981). Attems (1926) at first placed *Atopodesmus* in Cryptodesmidae Karsch, 1879, but later considered it an uncertain genus within Oniscodesmidae de Saussure, 1860 (Attems, 1940).

Hoffman (1980) included *Atopodesmus* in his list of Polydesmidea of uncertain status and family position. He placed *Asphalidesmus* in Dalodesmidae Cook, 1896, noting that the genus 'certainly appears to be a senior synonym of *Tasmaniosoma* [a Tasmanian dalodesmid], but the probability should be confirmed by the study of actual material, to include type material of *Atopodesmus* and *Lissodesmus* [another Tasmanian dalodesmid], of which the gonopod structure is still unknown' (Hoffman, 1980: 150).

Jeekel (1984) argued that neither *Asphalidesmus* nor *Atopodesmus* were likely to be dalodesmids. Silvestri's description of an *Asphalidesmus* male lacked mention of the sphaerotrichomes characteristic of Dalodesmidae, and *Atopodesmus* seemed to be very similar to *Asphalidesmus* in nonsexual characters. Both genera seemed to Jeekel to resemble the South African *Plygoxerotes* Verhoeff, 1939 and *Vaalogonopus* Verhoeff, 1940, suggesting that the Tasmanian genera might be referable to Vaalogonopodidae Verhoeff, 1940. After further discussion of similar polydesmoids, including the monotypic *Atopogonus* Carl, 1926 from New Caledonia, Jeekel (1984) reduced Vaalogonopodidae to Vaalogonopodinae and Atopogonidae Verhoeff, 1941 to Atopogoninae. He placed the two new subfamilies in Haplodesmidae Cook, 1895, where they joined Haplodesminae, Helodesminae and Prosopodesminae, which had been established by Hoffman (1980) from Haplodesmidae, *Helodesmus* Cook, 1896 and *Prosopodesmus* Silvestri, 1910, respectively.

Jeekel (1984) eoncluded by accepting the two Tasmanian genera as haplodesmids, but without subfamily placement.

The following year, Jeekel (1985) published a key to families and non-paradoxosomatid genera of eastern Australian Polydesmida. According to the key, the non-sexual characters reported for *Asphalidesmus* and *Atopodesmus* would place these genera in Haplodesmidae. However, the only eastern Australian genus referred to this family in Jeekel's key is *Agathodesmus* Silvestri, 1910, based on *Agathodesmus steeli* Silvestri, 1910 from New South Wales. *Agathodesmus* had not been placed in a family by Attems (1940) and had been assigned to Dalodesmidae by Hoffman (1980).

In a later paper, Jeekel (1986) referred to his earlier discussions of Australian Haplodesmidae and noted that 'In the meantime, Dr P. M. Johns, Christchurch, New Zealand (pers. comm.) assured me that in his opinion *Asphalidesmus* Silvestri is a member of the family Dalodesmidae rather than a haplodesmid. This leaves only *Atopodesmus* Chamberlin and *Agathodesmus* Silvestri as potential Australian Haplodesmidae. Unfortunately, the male characters of these two genera are unknown, so that as yet no certainty can be obtained' (Jeekel, 1986: 46). Jeekel (1986: 35) went on to describe a new haplodesmid species from Queensland, *Atopogonus bneeulentus*, characterising its collection in 1981 as 'the first unquestionable record of the group from Australia.'

In this paper I redescribe *Asphalidesmus leae* Silvestri, 1910 and *Atopodesmus parvus* Chamberlin, 1920. The two species have widely separated ranges in Tasmania but are locally abundant, and my descriptions are based on examination of more than 500 specimens deposited in the Queen Victoria Museum, Launceston, Australia. I do not consider that there are sufficient differences in gonopod structure and non-sexual details to maintain separate genera for these Tasmanian forms, and I therefore reduce *Atopodesmus* to a synonym of the older *Asphalidesmus*, which I redefine below.

Haplodesmidae seem to have become a 'temporary storage area' for genera of small polydesmoids with dense metatergal tuberculation and lateral expansion of the collum or the paranota of the second tergite. Until more information becomes available about species in this group, it seems wisest to accept Jeekel's 1984 placement of *Asphalidesmus* in Haplodesmidae without assignment to a subfamily.

Haplodesmids are widespread in Australia and probably species-diverse (Black, 1997). At least one other Tasmanian species is in the Queen Victoria Museum collection, known from two female specimens from King Island; this elusive species will be described when mature males are collected.

Specimens listed under *Material examined* were killed and preserved in 75–80% ethanol. Preliminary drawings on graph paper were made using material cleared in 60% lactic acid and viewed at 100 or 200 x magnification through an eyepiece graticule. A Philips Electroscan ESEM 2020 operated in high-vacuum mode was used to examine preserved material which had been air-dried before sputter-coating with gold. SEM images were acquired digitally.

Note on spatial data. Universal Transverse Mercator (UTM) grid references are the spatial locators used by most field workers to define collecting localities in Tasmania. Collecting sites for all but a few of the specimens listed under *Material examined* (online at www.museum.vic.gov.au/memoirs/index.html) were estimated in the field to be within particular 100 m UTM grid squares on 1:25000 scale maps published by the State of Tasmania. The maximum horizontal error in these estimates is likely to be less than 100 m. Latitude/longitude equivalents given were calculated using GeoCale 4.20 (GeoComp Systems, Blackburn, Victoria) and are not as precise as the UTM grid references.

Abbreviations. MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts, USA; QVM, Queen Victoria Museum and Art Gallery, Launceston, Tasmania, Australia.

Order **Polydesmida** Leach, 1815

Suborder **Polydesmidea** Leach, 1815

Haplodesmidae Cook, 1895

Asphalidesmus Silvestri

Asphalidesmus Silvestri, 1910: 362.—Attems, 1926: 153.—Verhoeff, 1932: 1587.—Verhoeff, 1936: 2.—Attems, 1940: 205.—Jeekel, 1971: 313.—Hoffman, 1980: 150, 184.—Jeekel, 1984: 85.

Atopodesmus Chamberlin, 1920: 153.—Attems, 1926: 134.—Attems, 1940: 356.—Jeekel, 1971: 313.—Hoffman, 1980: 150, 186.—Jeekel, 1984: 85 (type species: *Atopodesmus parvus* Chamberlin, 1920 by original designation). (syn. nov.).

Type species. Asphalidesmus leae Silvestri, 1910, by original designation.

Included species. A. leae, A. parvus (Chamberlin, 1920) comb. nov.

Description. General appearance. Head plus 19 somites (fig. 1) in both sexes. Mature males 5–6 mm long, 0.7–0.9 mm in overall midbody width; mature females very slightly larger. Immature and some mature individuals completely unpigmented, appearing white to naked eye. Most mature (stadium VII) individuals pale yellow-brown on collum, metatergites and preanal ring, deepening to brown towards waist and bases of paranota, remainder of body very pale yellow, whole animal appearing yellow-brown to naked eye. Most mature individuals, but no immatures, encrusted with minute soil particles (see *Remarks).*

Head with granulated vertex to level of antennal sockets, otherwise smooth (fig 2), vertigial sulcus short and weakly impressed. Antennae short with stout antennomeres, sixth being longest and widest (fig. 2).

Collum almost entirely concealing head when extended animal is viewed from above, strongly convex and fitting head like a cap (fig. 2). Collum, metatergites and preanal ring with transverse rows of numerous, uniform tubercles (figs 4, 6, 8) on roughened cuticular surface, each tubercle bearing short, curved seta with a flared tip (fig. 4). Midbody tergites of mature individuals typically with 5–6 rows of tubercles.

Somites each with clearly defined prozonite and metazonite and with paranota based low on sides (fig. 3). Podous segments diminishing only slightly in width from anterior to posterior. Prozonite surface faintly reticulated, caudal margin of metazonite continuously fringed with minute teeth, each with tip bent away from body at a right angle (figs 3, 4, 6, 8).

Paranota of segment 2 expanded, extending forward to partly cover collum and backward to lie under the anterior edge of the paranota of segment 3, margin divided into 7–9 seta-bearing lobes (fig. 2). Remaining paranota (figs 6, 8) more or less uniform in size, those of segment 18 substantially smaller. Each paranotum flexed slightly downward (fig. 3), the posterior edge lower than the anterior edge. Anterolateral border of paranotum roughly arc-shaped with series of 3–4 indistinctly defined seta-bearing lobes, posterior border more or less at right angles to body with flat, round-bordered outgrowth, here called a *paranotal tag*, close to body (figs 6, 8). On most segments few seta-bearing tubercles similar to those on metatergite can be noted on inflated basal portion of paranotum.

Ozopores on segments 5, 7, 9, 10, 12, 13, 15–17, above and distal to centre of base of paranotum (figs 6, 8), each ozopore opening within short, column-like structure with well-defined, circular, upper rim (fig. 5).

Legs short (fig. 2), the tarsus being longest podomere. Setation normal (no sphaerotrichomes). Male leg podomeres somewhat inflated relative to those on female legs, male postfemur and tibia proportionally longer than those of female.

Telson with preanal ring completely covering anal valves as viewed from above, valves opening ventrally. Few macrosetae at apex of epiproct, 2+2 macrosetae on anal valves, 2 long macrosetae on hypoproct.

Male with ovoid gonopod aperture, posterior margin slightly raised (fig. 2). Gonopods in situ with coxae entirely contained within cavity, telopodites reaching to anterior leg-pair of segment 5 (fig. 2). Gonopod coxae short, tapering towards distal end, lightly joined (not fused) medially. Telopodite slender, setiferous on posterolateral surface from base to half to two-thirds of length, then splitting into 2 branches: anteriorly directed process which bends caudad, and posteriorly directed process bearing end of prostatic groove (figs 7, 9). Female with narrow, inconspicuous epigynal slit; cyphopods not examined. Juveniles very similar to adults in general appearance and details of tuberculation, but with less prominent paranota.

Distribution and ecology. Asphalidesmus spp. are so far known only from two widely separated areas in Tasmania (fig. 10). Within their respective ranges, *A. leae* and *A. parvus* occur on a variety of bedrocks and landforms in areas with annual rainfall from c. 650 to 2000 mm (winter maximum). Both species, however, are restricted to eucalypt forest and *Nothofagus* rainforest, within which they are found in and under wet rotting wood and in moist accumulations of leaf litter. *Asphalidesmus* spp. are gregarious and typically occur in multi-aged groups of 10–50 individuals spread over c. 0.1 m^2. They are exceptionally slow-moving millipedes. When disturbed they neither enroll, curl, walk quickly away nor readily release their grip on the substrate. Mating pairs are found throughout the year, although so far only one sample (*A. parvus*, QVM 23:8360) contains a pair preserved in copula.

Remarks. The differences between the gonopods of the two known *Asphalidesmus* species are large in comparison to those within many

better-known polydesmoid genera. On the other hand, the two species are virtually identical in nonsexual morphology, share some striking synapomorphies and are both apparently endemic to Tasmania. Thus the gonopod differences are likely to have evolved within a single lineage. The Chamberlin name *Atopodesmus* remains available if molecular studies of *Asphalidesmus* and new studies of related Australian polydesmoids justify the (re)placement of the Tasmanian species in separate genera.

It is remarkable that body colouring and encrusting soil matter are invariably absent in immature stadia of *Asphalidesmus* and almost always present in mature individuals, despite the fact that matures and immatures live side by side in the same microhabitats. Is there a cuticular change in stadium VII which allows *Asphalidesmus* to adsorb coloring matter from soil and decorate itself with particles?

Asphalidesmus leae Silvestri

Figures 1–4, 6, 7, 10

Asphalidesmus leae Silvestri, 1910: 362, fig. 8.—Attems, 1940: 205.—Jeekel, 1971: 313.—Jeekel, 1984: 85.

Holotype. Mature male, 'Hobart (Tasmania, A. Lea legit)' (Silvestri, 1920: 362), possibly in the Silvestri type collection in Portici, not examined.

Material examined. 166 specimens in QVMAG from 80 unique localities (Fig. 10) in northern Tasmania: Alarm River, Allen Creek, Arthur River, Big Creek, Bishops Creek, Black River, Blacktish Creek, Bonneys Tier, Borradale Creek, Brampton Creek, Cam River, Camp Creek, Chasm Creek, Christmas Hills, Crayfish Creek, Detention Falls, Devils Gate, Dial Creek, Dynans Bridge, East Gawler River, East Ridgley, Flowerdale River, Frankland River, Gawler River, Gog Range, Harris Creek, Hebe River, Holwell Gorge, Inglis River, Julius River, Keddies Creek, Keleey Tier, Kenzies Hill, Langford Creek, Lawson Plains, Lebrina, Library Creek, Little Claytons Rivulet, Little Donaldson River, Lobster Rivulet, Lone Star, Long Hill, Loyetea Peak, Lunta Tier, Meryanna, Meunna Hills, Montagu Swamp, Mt Arthur, Mt Riana, Paloona Dam, Peegra Road, Pioneer Link, Punchs Terror, Retreat, Roger River West, Salmon River, Saxons Creek, Sideling Range, Sisters Creek, Somerset, The Clump, Trowutta Caves, Venns Creek, Wyena, York Town Rivulet. For full details of localities, dates, collectors, specimens and registration numbers, see the online list at www.museum.vic.gov. au/memoirs/index.html, or contact the author.

Diagnosis. Differs from *A. parvus* as follows: (a) anterior process of gonopod telopodite slender, terminating at or below the level of the posterior process in a short, caudally directed hook; (b) paranotal tabs weakly produced or not apparent, no more prominent than lobes on anterolateral border of paranota (late stadium males and females).

Description. Paranotal tabs weakly produced (fig. 6) and not apparent on most paranota. Gonopod (figs 2, 7) with telopodite divided at about two-thirds its length into anterior and posterior processes. Basal portion of the telopodite fairly straight, tapering mesally, with short, stout setae on the posterior and posterolateral faces, the setiferous area terminating just proximal to the telopodite branching point. Posterior process directed slightly caudad and laterad, thinning to spatulate structure, concave mesally with coarsely toothed terminus, small uncus arising just proximal to concavity at about one-quarter length of branch. Prostatic groove running along anterior face of telopodite, curving caudad and mesad to terminate in flattened solenomerite arising within branch concavity, solenomerite bending laterad and cephalad and almost extending to level of branch terminus. Anterior process of telopodite slender, bending sharply caudad at about one-third its length, tapering and terminating in caudally pointed hook at about level of tip of solenomerite.

Distribution. Asphalidesmus leae occurs from near sea level to c. 750 m in northern and northwestern Tasmania (fig. 10). Within its range of c. 8000 km² *A. leae* seems to prefer wet forest habitats. (See also the discussion of *Asphalidesmus* distribution and ecology.)

Remarks. Remarkably little morphological variation has been noted in *A. leae*. Gonopods of males collected 200 km apart, at opposite ends of the *A. leae* range, appear identical.

My identification of the QVM material with *A. leae* is based on Silvestri's text description and gonopod drawing (fig. 7A). However, Silvestri gives the type locality as Hobart, which is clearly wrong (fig. 10). The collector, Arthur Lea, was Government Entomologist of Tasmania beginning in 1899 (Marks, 1991: 207). Although Lea was based in Hobart, he was an active field naturalist and presumably collected *A. leae* on a trip to the north of the island sometime between 1899 and 1910. It is unclear how the confusion in type locality arose.

Asphalidesmus parvus (Chamberlin) comb. nov.

Figures 1, 2, 5, 8–10

Atopodesmus parvus Chamberlin, 1920: 154.—Attems, 1940: 357.—Jeekel, 1971: 313.—Jeekel, 1984: 85.

Holotype. mature female, 'Tasmania (G.H. Hardy)' (Chamberlin, 1920, p. 154), MCZ, no. 4648. Paratype: immature female, collection details as for holotype, MCZ, no. 4649.

Other material examined: 398 specimens in QVMAG from 83 unique localities in south-eastern Tasmania: Anglers Creek, Baldy Creek, Bellettes Creek, Big Sassy Creek, Black Hill, Blind Creek (Maria Island), Blue Gum Spur, Browns Creek, Chauney Vale, Counsel Creek (Maria Island), Douglas Creek, Entrance Cave, Espies Craig, Flash Tier, Four Mile Creek (Maria Island), Huon River (Arve Road), Huon River (Edwards Road), Huon River (Manuka Road), Lake Sydney, Lenah Valley, Macgregor Peak, Maelaines Creek, Mitchelmores Creek, Mother Browns Bonnet, Mt Hobbs, Mt Maria (Maria Island), Mt Misery, Mt Ponsonby, Mt Rumney, Mt Tobin (Bruny Island), Mystery Creek Cave track, Ned Ryans Creek (Maria Island), Nugent, Old Farm Road, Organ Pipes (Mt Wellington), Paradise Gorge, Pendulum Palace (cave PB-12, Precipitous Bluff), Phipps Creek, Pine Hut Creek (Maria Island), Pirates Road, Ravens Hill, Robinsons Creek (Maria Island), Sand River, Sandspit River, Sassafras Hill, Silver Hill Road, Stormlea, Strathblane, Tahune Bridge, Three Thumbs, Tiger Creek, Tinderbox, Tobys Hill, Tooms White Gum Reserve, Waterfall Creek, Wilsons Ridge, Woodsdale, Yarlington Tier. For full details of localities, dates, collectors, specimens and registration numbers, see the online list at www.museum.vic.gov.au/memoirs/index.html, or contact the author.

Diagnosis. Differs from *A. leae* as follows: (a) anterior process of gonopod telopodite robust, at least twice as long as posterior process, terminating in a long, flattened, caudally directed structure usually with 10–12 coarse teeth; (b) paranotal tabs strongly produced in late stadium males and females, clearly larger and more distinct than lobes on anterolateral border of paranota.

Description. Paranotal tabs large and apparent on most paranota (fig. 8). Gonopod (figs 2, 9) with telopodite divided at just over half its length into anterior and posterior processes. The basal portion of the telopodite fairly straight, slender, tapering mesally, with short, stout setae on posterior and posterolateral faces, setiferous area terminating just proximal to telopodite branching point. Posterior process directed slightly caudad and divided into lateral and mesal branches. Lateral subbranch in turn divided into distal solenomerite and proximal process which bends laterad, bears minute teeth and reaches about half length of solenomerite. Mesal subbranch short, stout, erect, terminating at level of posterior process on lateral subbranch. Prostatic groove running near anteromesal face of telopodite, barely curved, terminating near tip of slightly flattened solenomerite. Anterior process of telopodite a large, anteroposteriorly flattened structure, bending sharply caudad at about two-thirds its length and tapering into laterally flattened comb bearing c. 10–12 coarse teeth pointed towards posterior process. From telopodite branch point, anterior process extending just over twice distance reached by the solenomerite.

Distribution. A. parvus ranges over c. 8000 km^2 in southern and south-eastern Tasmania, including Bruny and Maria Is (fig. 10). It is common in wet forest and in wet places (flowlines, south-facing slopes) in dry forest. On the Tasmanian mainland *A. parvus* occurs from near sea level to c. 950 m (on Mt Wellington, near Hobart). *A. parvus* has also been collected in limestone caves in far southern Tasmania, where it is likely to be a troglophile or accidental. (See also the discussion of *Asphalidesmus* distribution and ecology.)

Remarks. The original description of *A. parvus* includes the line 'Caudal margin of most keels with a single large conical tooth close to the base' (Chamberlin, 1920: 154). A large paranotal tab is apparent on segments 7–15 of the holotype and segments 5–15 of the paratype, distinguishing these specimens as *A. parvus* rather than *A. leae.*

Like *A. leae, A. parvus* varies very little across its range, but in males from three sites on Forestier Peninsula (QVM 23:41551, QVM 23:8324 and QVM 23:41528) and one on Tasman Peninsula (QVM 23:8325) the teeth on the anterior process of the gonopod are reduced or absent. The gonopodal teeth appear normal on a male from a nearby 'non-peninsular' site (QVM 23:8327). The two peninsulas are already recognised as a biogeographical subregion of Tasmania for the presence of a locally endemic snail and millipede, and the apparent absence of at least two other terrestrial invertebrates (Mesibov, 1996).

The type locality of *A. parvus* (Tasmania) unfortunately remains inexact. However, the collecting date can be roughly bracketed in time. G.H. Hardy worked in Western Australia before serving as Assistant Curator of the Tasmanian Museum in Hobart from 1913 to 1917, after which he studied at the University of Sydney (Marks, 1991: 216). The Annual Report of the

Director of the Museum of Comparative Zoology at Harvard College to the President and Fellows of Harvard College for 1914–1915 records (p. 31) that material had been received by the MCZ during the year from 'E.H. Hardy' (sic.). Ralph Chamberlin, who at the time was Curator of Arachnids, Myriopods (sic.) and Worms at the MCZ, described 14 Tasmanian myriapod species from Hardy collections (Chamberlin, 1920) and gives a collecting date 'February 1915' for one of these, the millipede *Notodesmus scotius*. Finally, a possibly original label with the *Lissodesmus modestus* type (no. 4644) says 'Jan 1915 Russell Falls'. It thus seems likely that Hardy collected *A. parvus* in the period from 1913 to the austral summer of 1914–1915.

Acknowledgements

I thank Dr David Steele, University of Tasmania, for taking SEMs of *Asphalidesmus* specimens. At the MCZ in October 2000, Dr Gonzalo Giribet generously provided working space for an examination of Chamberlin types, and Special Collections Librarian Dana Fisher kindly found documents for me from the Chamberlin era. For recent *A. parvus* collections I thank Kevin Bonham, a malacologist with a good eye for tiny millipedes. Finally, I am very grateful to Mark Harvey, Rowland Shelley and an anonymous referee for constructive comments on a draft of this paper.

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Figure 1. Whole-animal views of mature male *A. leae* (left; QVM 23:8371) and *A. parvus* (right; QVM 23:8389). Scale bars = 1 mm.

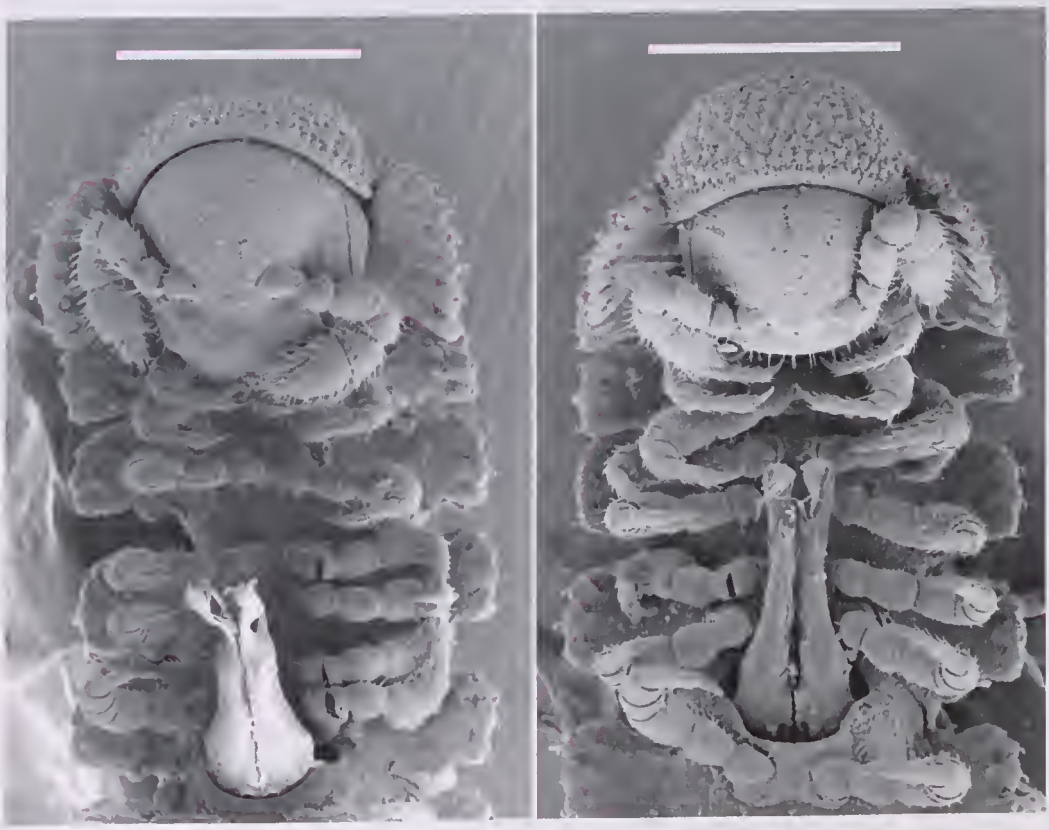

Figure 2. Ventral views of anterior segments of mature male *A. leae* (left; QVM 23:8322) and *A. parvus* (right; QVM 23:8360). Scale bars = 0.5 mm.

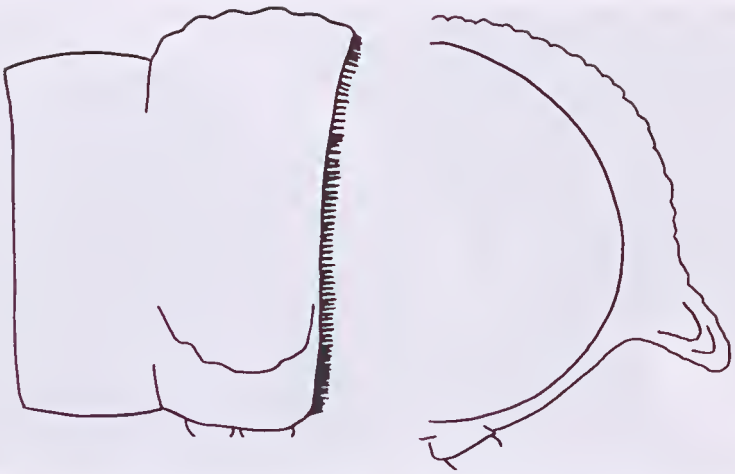

Figure 3. Outline drawings of left profile (left) and anterior half-section (right) of segment 8 of mature female *A. leae* (QVM 23:8381).

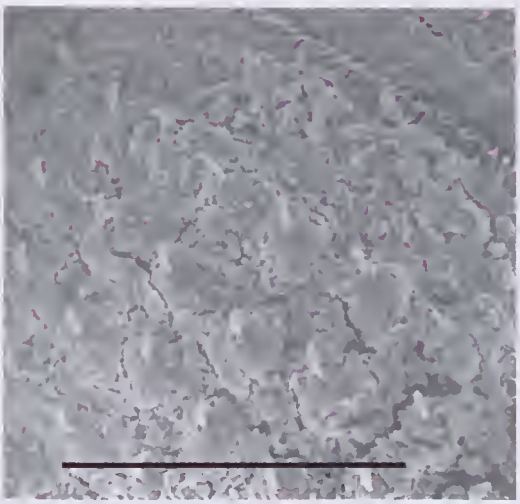

Figure 4. Rear portion of midbody tergite of mature male *A. leae* (QVM 23:8371); anterior is to lower left. Scale bar = 150 µm.

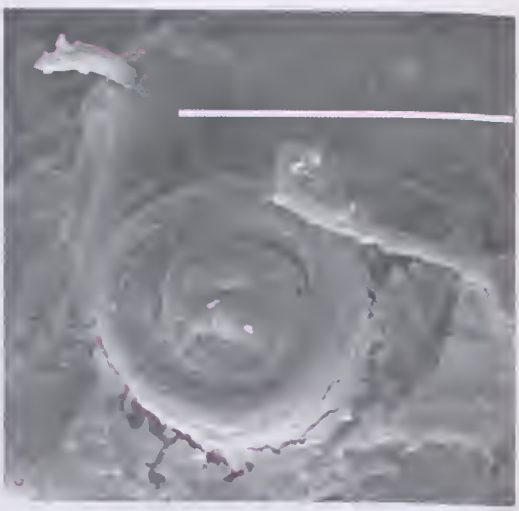

Figure 5. Ozopore on segment 9 of mature male *A. parvus* (QVM 23:8389). Scale bar = 50 µm.

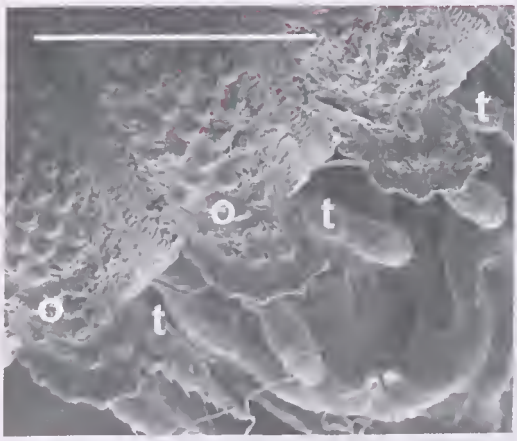

Figure 6. Paranota of segments 9–11 of mature female *A. leae* (QVM 23:41535) showing paranotal tabs (t) and ozopores (o). Scale bar = 0.5 mm.

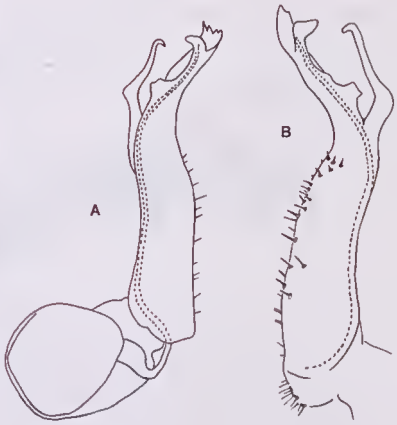

Figure 7. Gonopod of *A. leae*. (A) mesal view of left gonopod of holotype, redrawn from Silvestri (1910); (B) mesal view of right gonopod telopodite of male from northwest Tasmania (QVM 23:41717). Drawings not to same scale. For posterior view, see Fig. 2.

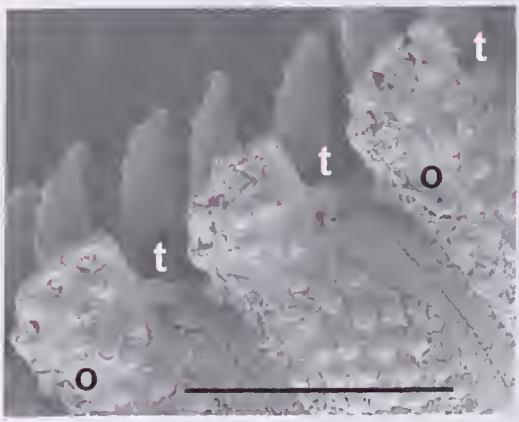

Figure 8. Paranota of segments 10–12 of mature female *A. parvus* (QVM 23:8389) showing paranotal tabs (t) and ozopores (o). Scale bar = 0.5 mm.

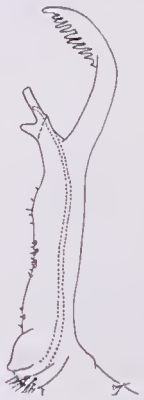

Figure 9. Gonopod of *A. parvus*. Mesal and slightly dorsal view of right gonopod telopodite of male from southeast Tasmania (QVM 23:24743). For posterior view, see fig. 2.

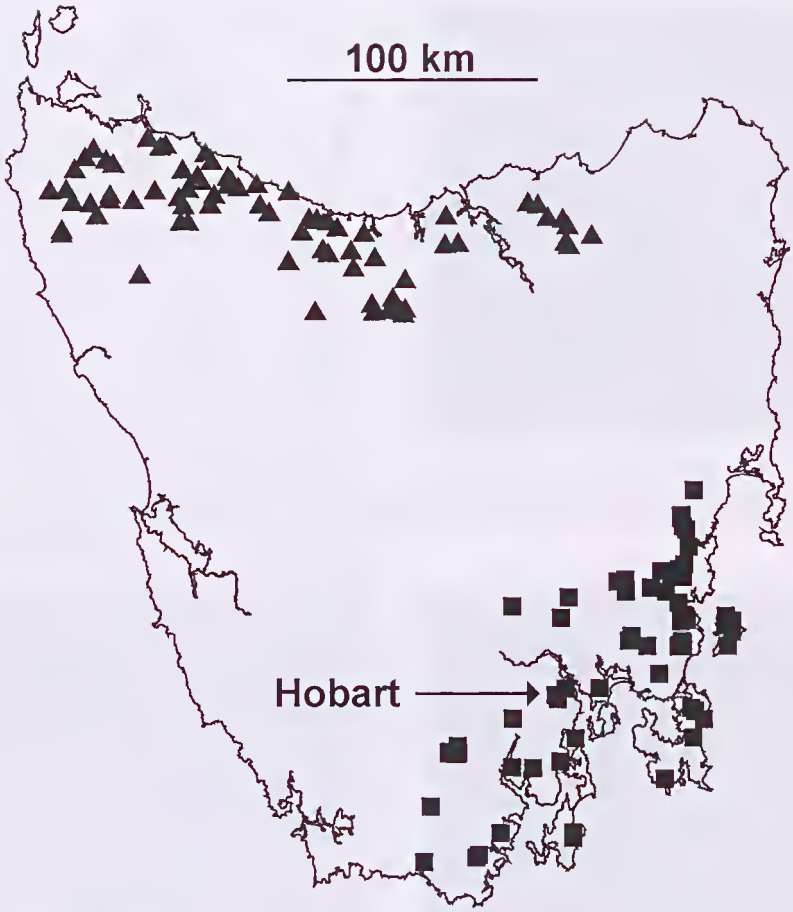

Figure 10. Tasmanian localities of *A. leae* (triangles) and *A. parvus* (squares).

Memoirs of the Museum of Victoria 59(2): 541–553 (2002)

PYCNOGONUM (PYCNOGONIDA: PYCNOGONIDAE) FROM AUSTRALIA WITH DESCRIPTIONS OF TWO NEW SPECIES

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Abstract

Staples, D.A., 2002. *Pycnogonum* (Pycnogonida: Pycnogonidae) from Australia with descriptions of two new species. *Memoirs of Museum Victoria*. 59(2):541–553

Australian representatives of the genus *Pycnogonum* Brünnich, 1764 are reviewed. *Pycnogonum carinatum* sp. nov. and *P. clarki* sp. nov. are described and compared with their congeners. *Pycnogonum occa* Loman, 1908 is provisionally recorded from the continental slope of eastern Bass Strait, greatly extending its geographic range from tropical to temperate Australia. The range of *P. moolenbeeki* Stock, 1992 is extended to northern Australia. Type specimens of *P. aurilineatum* Flynn, 1919, *P. torresi* Clark, 1963, *P. tuberculatum* Clark, 1963 and the New Zealand species *P. anovigerum* Clark, 1956 are re-examined. The male of *Pycnogonum aurilineatum* and glands surrounding the mouth of *Pycnogonum* species are described. The arrangement of gonopores in five species is reviewed. Gland-like coxal markings were noted in several species. Abnormal development in two specimens of *P. clarki* sp. nov. is recorded. A key to the seven Australian species is provided.

Introduction

The genus *Pycnogonum* Brunnich, 1764 consists of over sixty species characterized by a robust body, well developed proboscis and complete absence of chelifores and palps. In the absence of ovigers in some species, eggs are cemented directly to the ventral surface of the trunk. *Pycnogonum* are specialized feeders, most often recorded in association with anemones on which they feed. Records are predominantly from shallow waters but are known from depths exceeding 2000 m. This paper reviews the Australian fauna and reports on two additional species new to science. Of the seven species now recorded, five appear to be endemic to the Australian region. The arrangement of gonopores in males and females was examined and pale spots (herein provisionally referred to as coxal glands) on the coxae noted by Bouvier, 1913 and Flynn, 1919 were recorded in several species. Gland-like structures surrounding the mouth were also recorded..

Measurements of the coxae can vary significantly depending upon which surface they are taken. For this reason measurements have been taken on the lateral surface that presents the greatest length and excludes the articular membrane. Similarly, the proboscis is measured laterally excluding the articular membrane which in some cases exceeds 20% of the proboscis length when extended. Trunk length is measured from anterior margin of cephalothorax to base of abdomen. Type material lodged in Australian institutions was re-examined. New type material has been lodged in Museum Victoria. Abbreviations are: NMV, Museum Victoria, Melbourne; AM, Australian Museum, Sydney; MRG, Marine Research Group of Victoria; TM, Tasmanian Museum, Hobart; NTM, Northern Territory Museum, Darwin. One millimetre scale bars refer to trunk size.

PYCNOGONIDAE Wilson

Pycnogonum Brunnich, 1764

Remarks. The genus *Pycnogonum* is divided into three subgenera based on the characteristics of the male oviger (Stock, 1968): *Pycnogonum*, oviger 8-9 segmented, terminal claw present; *Retroviger*, oviger 4-7 segmented, with or without terminal claws; and *Nulloviger*, without ovigers. Of the seven Australian species

recorded, three can now be assigned to *Nulloviger* and two to *Retroviger*. These are *P. (Nulloviger) carinatum* sp.nov., *P. (Nulloviger) tuberculatum*, *P. (Nulloviger) moolenbeeki*, *P. (Retroviger) clarki* sp. nov. and *P. (Retroviger) aurilineatum*. Males of *P. occa* Loman, 1908 and *P. torresi* have not been found and cannot be assigned to a subgenus. Hooper (1980) recorded *P. rickettsi* Schmidtt, 1934 from Arrawarra Headland, northern New South Wales but re-examination of his collection found that species not to be present. The type locality for *P. rickettsi* is Monterey Bay, California. Until further material comes to hand, this species is not included as an Australian record.

Key to Australian species of *Pycnogonum*

1. Dorsomedian processes on trunk segments 1-3 pointed, height about 3 times basal diameter.....*P. occa* Loman, 1908
— Dorsomedian processes on trunk segments 1-3 blunt or rounded, height about equal to, or less than basal diameter.....2
2. Proboscis with dorsomedian tubercle 3
— Proboscis without dorsomedian tubercle..... 4
3. Proboscis greater than 40% length of trunk. Tibia 1 greater than 60% length of femur. Propodus 3 times as long as wide.....*P. tuberculatum* Clark, 1963
— Proboscis less than 40% length of trunk. Tibia 1 less than 60% length of femur. Propodus about 2.5 times as long as wide.....*P. moolenbeeki* Stock, 1992
4. Post-ocular tubercle present .....*P. carinatum* sp. nov.
— Post-ocular tubercle absent 5
5. Tibia 2 greater than 50% of tibia 1. Abdomen rounded.....*P. torresi* Clark, 1963
— Tibia 2 very short, less than 20% of tibia 1. Abdomen truncate..... 6
6. Trunk conspicuously reticulate, unpigmented. Femur and propodus of about equal length, propodal and tarsal spines loosely arranged in median row.....*P. clarki* sp. nov.
— Trunk shagreened, typically dark with pale dorsomedian stripe. Femur longer than propodus, tarsal and propodal spines arranged into dense clusters ..... *P. aurilineatum* Flynn, 1919

Pycnogonum (Nulloviger) carinatum sp. nov.

Figure 1A-G

Material examined. Holotype. Vic. Beware Reef, near Cape Conran (37°49.35′S, 147°47.39′E), 5-6 m, SCUBA, T. O'Hara and A. Plummer, 15 Apr 1998, (stn WV 11), NMV J48800 (male, ovigerous).

Other material. Vic. Southern Port Phillip Bay (38° 17.30′S, 144° 41.40′E), 7 m, dredge, MRG, 25 Jul 1987 (stn SPPS 5), NMV J48801 (1 female, gravid). Victory Shoal, southern Port Phillip Bay (38°17.00′S to 38° 16.80′S, 144° 37.70′ to 144° 38.30′E), 3–6 m, SCUBA/dredge, MRG, 30 Mar 1986, (stn SPPS 3), NMV J48802 (1 male, ovigerous. Trunk of specimen lost). 'The Wall', Port Phillip Heads, in red algae collection, 15 m, SCUBA, J.E. Watson, 9 Jun 1984, NMV J48803 (1 female, gravid). Victory Shoal, Port Phillip Bay, 6 m, dredge, MRG, 30 Mar 1986, (stn SPPS 3), NMV J48804 (protonymphon, 3 pair of legs developed). Off Shortland's Bluff, Port Phillip Bay (38° 17.20′S to 38° 16.90′S tn 144° 38.80′E to 144° 40.30′E), 5–15 m, dredge, MRG, 02 Nov 1986, (stn SPPS 4), NMV J48805 (protonymphon, 3 pair of legs developed). Cheviot Beach, Point Nepean (38° 18′S, 144° 40′E), *Phyllospora/Ecklonia* habitat, 3-3.5 m, SCUBA, T. O'Hara and A. Plummer, 31 Mar 1998, (Stn WV5), NMV J48806 (2 females). Queenscliff, Port Phillip Bay, 7 m, SCUBA, D. Staples, 20 Mar 1992, NMV J48807 (1 male?). Cape Paterson, Twin Reefs (38° 40′S, 145° 39′E), intertidal, G.C.B. Poore and R.S. Wilsnn, 5 Mar 1982, (stn CPA 20), NMV J48808 (1 specimen, sex indeterminate). Port Phillip Bay (38° 17.00′S to 38° 16.80′S, 144° 37.70′E to 144° 38°30′E), 3–6 m, SCUBA, MRG, 21 Jan 1989, (stn SPPS 3), NMV J48809 (1 juv). Cape Paterson, 1 km E of Harmers Haven (38° 34′S, 145° 40′), approx. 300 m offshore, algal turf, 5-6 m, SCUBA, R.S. Wilson and C. Larson, 6 Mar 1982, (stn CPA 15), NMV J48810 (1 female). Tas. Arched I., (43°26.32′ S 147°20.19′E), 6 m, J. Walls, (undated), NMV J48811 (1 specimen, sex indeterminate). WA, Breaksea I., SW corner, (35° 3.90′S 118° 2.50′E), red algae between *Ecklonia*, 15 m, SCUBA, G.C.B. Poore and H.M. Lew Ton, 7 Apr 1984, (Stn SWA14), NMV J48815 (1 male?).

Diagnosis. Trunk with post-ocular tubercle, segments 1-3 with raised transverse ridges each with blunt dorsomedian tubercle. Ovigers absent,

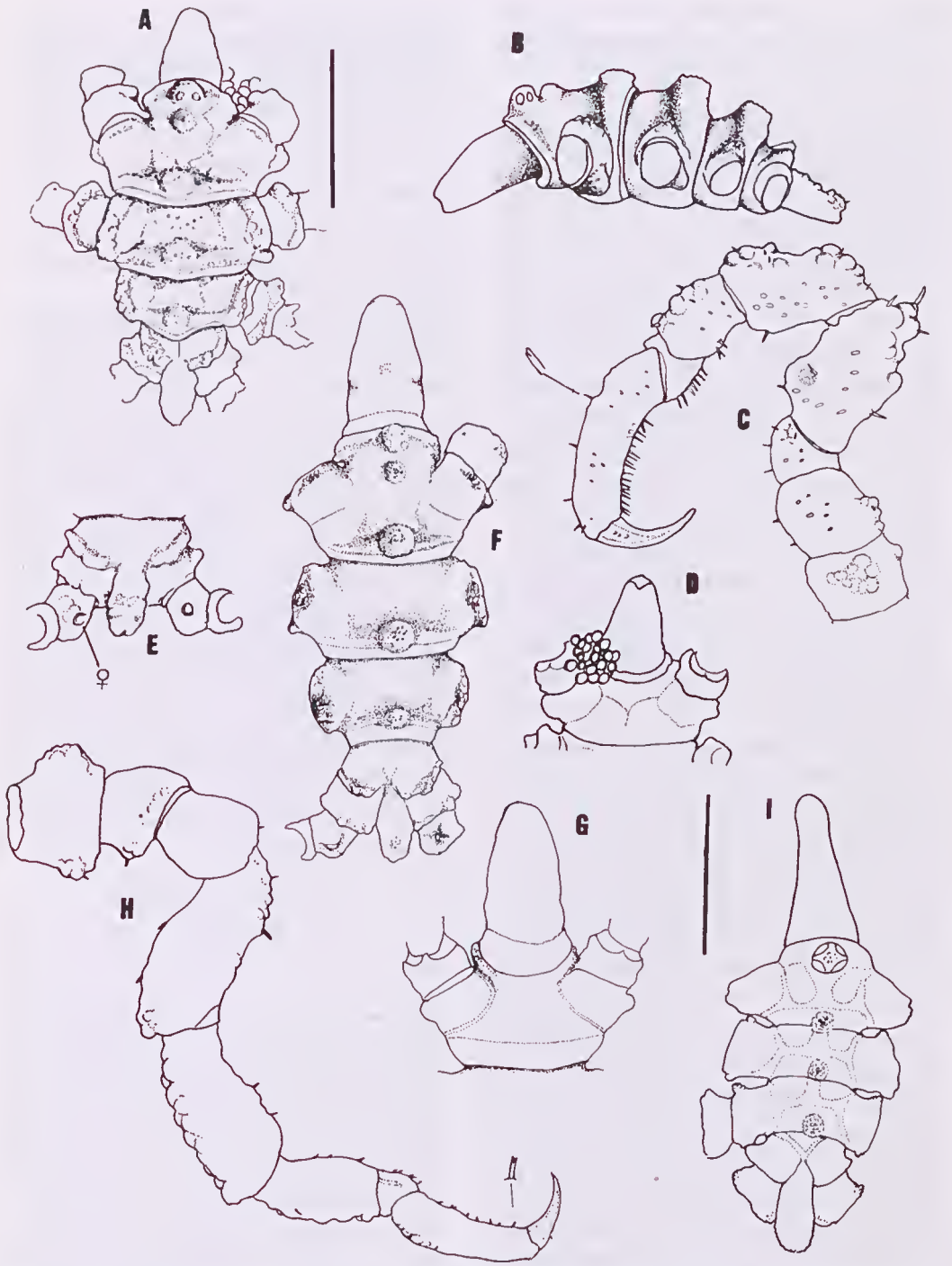

Figure. 1. *Pycnogonum carinatum* sp nov. NMV J48800 (figures A–D holotype, male). A, trunk dorsal view. B, lateral view. C, third leg. D, ventral view proboscis and segment 1. NMV J48801 (figures E–G female) E, dorsal view segment 4, coxae 1 and 2. F, trunk dorsal view. G, anterior ventral showing extended articular membrane. *Pycnogonum torresi* AM P13689 (holotype, female) H, third leg. I, trunk dorsal view.

both sexes. Dorsal reticulations obscure or absent. All leg segments tuberculate dorsally, propodus longest segment, sole spines distally cleft, auxiliary claws absent.

Description. Integument finely granular, reticulations clearly evident ventrally, obscure, or not visible in dorsal view, single post-ocular tubercle slightly lower than ocular tubercle followed by three raised transverse ridges on trunk segments 1–3, each with blunt dorsomedian tubercle, more prominent in some specimens than others. Lateral processes diverging, distally separated by about own diameter, each with raised dorsodistal nodulous ridge most prominent middorsally and posteriorly–directed ventrodistal process, most pronounced on segments 1–2. Ocular tubercle near anterior margin of cephalothorax, height less than diameter, 4 eyes lightly pigmented. Proboscis robust, slight constriction at about one-third length, tapering distally, without dorsal tubercles. Oral glands present. Articular membrane between trunk segments and at base of proboscis wide, capable of considerable extension and retraction, membrane at base of proboscis folded or collar-like when contracted. Abdomen not quite reaching distal margin of coxa 2 of fourth pair of legs, directed horizontally or slightly ventrad, distally rounded in dorsal view, bearing nodulous dorsodistal elevation, anus terminal. Ovigers absent in both sexes.

Legs: Coxa 1 of all legs with pronounced anteriodistal process, dorsodistal margin developed into rugose collar, more pronounced in some specimens but usually absent on the first pair of legs. Coxa 2 with distal rugose collar. Coxae 1 and 2 of about equal length, longer than coxa 3, femur longer than tibia, tibia 1 longer than tibia 2; propodus longest segment. Main claw about 60% of propodal length. Femur with prominent ventroproximal swelling and 2 nodulous dorsodistal lobes, prominent spine between lobes, few smaller spines, some cleft, scattered on all segments. All segments tuberculate dorsally, tubercles themselves minutely granular. Tarsal and propodal sole spines cleft at apex, number widely variable between legs of same specimen and between individuals, consistently less abundant on fourth pair of legs. Sole spines range from 10-30, about 6 spines grouped at base of main claw; tarsal spines 7-30. Auxiliary claws absent. Male gonopores tiny, on ventral surface coxa 2 of fourth pair of legs. Female gonopores well defined, on dorsodistal surface of coxa 2 of fourth pair of legs. Variably defined coxal glands are present on all legs of both sexes.

Measurements (mm). Holotype. Trunk length, 1.75; trunk width (across second lateral processes), 1.03; proboscis length, 0.65; abdomen, 0.04; third leg, coxa 1, 0.21; coxa 2, 0.20; coxa 3, 0.16; femur, 0.42; tibia 1, 0.35; tibia 2, 0.25; tarsus (ventral), 0.17; propodus, 0.50; claw; 0.28.

Distribution. Central Victorian coast, SE Tasmania and SW Western Australia; 3–15 m depth.

Etymology. The specific name alludes to the raised transverse ridges found on the dorsal surface of the trunk segments.

Remarks. The integument has the appearance of being embedded with what look like air bubbles or translucent beads which appear not to communicate with the surface. This condition may be as in *P. crosnieri* Stock, 1991, described as "granulated and pitted". *Pycnogonum carinatum* belongs to a group of species lacking auxiliary claws and ovigers in both sexes. It shares the presence of a single postocular tubercle with *P. portus*, Barnard, 1946, *P. microps*, Loman, 1904, *P. angulirostrum*, Stock, 1959, *P. arbustum*, Stock, 1966h, *P. forte*, Flynn, 1928 and *P. tumulosum*, Loman, 1908. The new species is closest to *P. microps* from which it can be distinguished by tuberculate and nodulate leg segments, dorsomedian trunk tubercles and distally rounded abdomen (truncate in *P. microps*). *P. carinatum* is smaller than material of *P. anovigerum* from New Zealand, has more prominent trunk ridges and ocular tubercle, possesses a prominent postcular tubercle, and shorter abdomen with terminal anus. The anus in *P. anovigerum* is on the ventrodistal surface of the abdomen.

Pycnogonum torresi Clark

Figure 1H–I

Pycnogonum torresi Clark, 1963: 76–77, figs 37 A–D.

Material examined. Holotype. Queensland, Murray Island, Torres Strait, 10-15 m, C. Hedley and A.R. McCulloch, 1907, AM P13689 (1 female).

Remarks. The body is straw-coloured in preserved material, without markings. Propodal sole spines are blunt, split distally; the proboscis slightly bulbous distally; and oral glands small and inconspicuous. Reticulation of the trunk is more evident than illustrated by Clark. This specimen appears to have dried out at some stage and is in a fragile condition with some damage. Circular markings on the dorsal surface of coxa 2 of all legs appear to support Clark's observation that the specimen is a female, however small

perforations in the position normally occupied by the male gonopores on the damaged last pair of legs may indicate the specimen is male. Additional material is required to clarify the arrangement of gonopores in this species.

Distribution. Known only from type locality.

Pycnogonum (Retroviger) clarki sp. nov.

Figure 2A–G

Pycnogonum species.—Hooper, 1980: 475

Material examined. Holotype. New South Wales, Arrawarra Headland (30°17′S, 153°15′E), 0-2.5 m, J.N.A. Hooper 1976, NMV J48812 (male, with slide). Paratypes. Collected with holotype, NMV J48817 (1 female, 1 juvenile male).

Diagnosis. Integument strongly reticulate, trunk segments 1-3 with well-defined, rounded processes. Oviger male only, 7-segmented. Propodus approximately equal to length of femur. Tibia 2 shorter than wide. Propodal sole spines cleft at apex, loosely arranged in narrow field along length of propodal sole. Auxiliary claws absent.

Description. Entire integument (except for propodus and ovigers) strongly reticulate, straw-coloured in preserved state, without markings. Trunk fully segmented, first 3 trunk segments armed dorsodistally with well defined, rounded process each about equal in height to the ocular tubercle. Lateral processes narrowly separated at base, short, wider than long, segment 4 with low, granular dorsodistal boss. Ocular tubercle low, height less than basal diameter, 4 large eyes lightly pigmented. Proboscis robust, slightly tapered and down-curved, slight constriction at about half length, articular membrane at base of proboscis wide when extended. Oral glands present. Abdomen wedge-shaped, reaching to distal margin of coxa 1 on fourth pair of legs, swollen in mid region, truncate with low dorsodistal tubercle, anus terminal. Oviger of male 7-segmented with strong terminal claw; last segment with 2 small ventral spines and 1 dorsal spine, remaining segments devoid of spines, obscure suture lines separate segments 1–3. Lengths (mm) of male oviger joints are: seg.1, 0.03; seg. 2, 0.05; seg. 3, 0.14; seg. 4, 0.15; seg. 5, 0.08; seg. 6, 0.10; seg. 7, 0.12; claw, 0.09. Oviger absent in female.

Legs: Femur and tibia 1 subequal. Coxae 1–3 of about equal length, each with distal coarse granular collar, slightly raised on coxae 1–2, articular membrane between segments wide. Tibia 2 as in *P. aurilineatum*, shorter than wide and separated from tarsus by a suture line. Propodal sole armed with 30-40 spines each with a cleft apex, loosely arranged in a narrow field along length of propodus. Ventrally, coxa 3, femur, tibiae 1 and 2 and tarsus support groups of similar spines in lesser numbers. Main claw about 60% of propodus. Auxiliaries absent. Female gonopores large, well defined, situated on dorso-posterior surface of coxae 2 of fourth pair of legs. Male gonopores tiny, ventral, on coxa 2 of last pair of legs. Obscure middorsal coxal glands present on coxa 2 of all legs in both sexes. These spots are free of reticulations found in the surrounding integument.

Measurements (mm). Holotype: trunk length, 1.70; trunk width (across second lateral processes), 1.4; proboscis length, 1.0; abdomen 0.40; third leg, coxa 1, 0.30 ; coxa 2, 0.35; coxa 3, 0.30; femur, 0.50; tibia 1, 0.52; tibia 2, 0.17; tarsus, 0.10; propodus, 0.53; claw 0.31.

Distribution. Known only from type locality.

Etymology. This species is named for Prof. W.C. Clark in recognition of having first examined these specimens and for his significant contribution to our knowledge of Australian representatives of this family.

Remarks. This species is close to *P. aurilineatum* but is significantly smaller in overall dimensions and bulk. Total length is less than one-third that of (a typical) *P. aurilineatum*. The conspicuous reticulations, absence of pigmentation and body markings and relative length of the propodus (approximately equal length to the femur, about 70 %, in *P. aurilineatum*) further serve as distinguishing characters. The number and arrangement of propodal and tarsal spines, the number of oviger spines, and the less prominent dorsal swelling of the femur are differences that could be age-dependent, but when considered in combination may serve as additional points of difference. Both the female and juvenile are abnormal specimens. The juvenile has four legs on the left side but only three legs on the right. The dorsal surface of trunk segment 4 of the female is incompletely developed and the middorsal tubercle is atrophied and offset. The dorsal tubercle on segment 3 is low, flat and wart-like, possibly also an abnormality. On the ventral surface, trunk segmentation is complete. Such morphological abnormalities are not unique but nevertheless rarely recorded. In both instances there is no evidence of trauma. *Pycnogonum gnyanae* Stock, 1975 also resembles this species but can be distinguished by the longer tibiae 2 and placement of the female gonopores on legs 3 and 4.

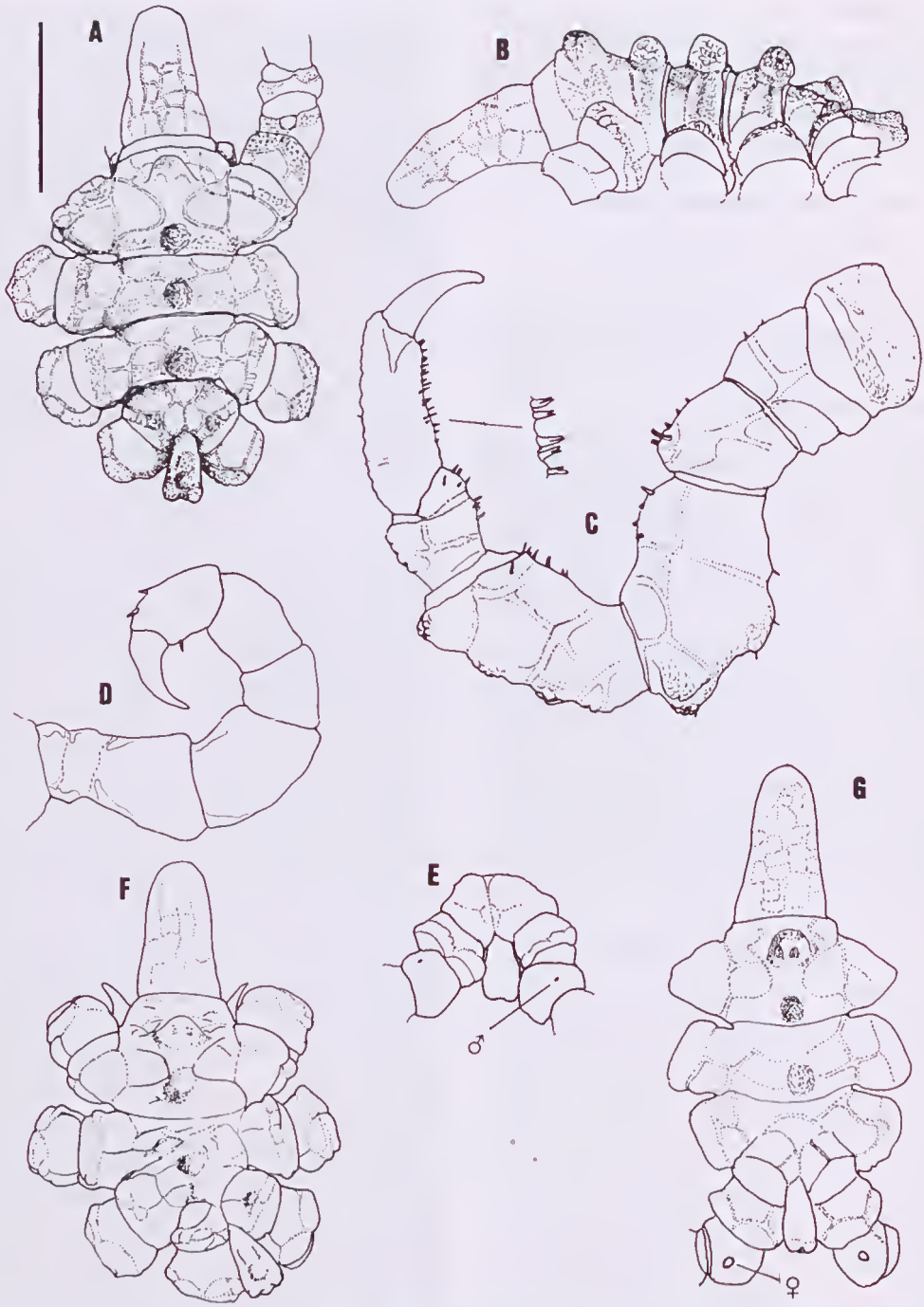

Figure. 2. *Pycnogonum clarki* sp. nov. NMV J48812 (all figures except E, F, of male holotype). A, trunk, dorsal view. B, trunk lateral view. C, third leg. D, oviger. E, ventral view segment 4. NMV J48817 F, juvenile male trunk, dorsal view. G, female trunk, dorsal view.

Pycnogonum occa Loman

Figure 3A–D

Pycnogonum occa Loman, 1908: 35-36, pl. 12 figs 171–174.—Bouvier, 1922:116.—Stock, 1966a: 401 (in key).—Stock, 1968: 61-62, fig 22c–e.—Child, 1988: 27.—Stock, 1997: 389-409.

Material examined. Victoria, S of Point Hicks eastern Bass Strait (38°19.6'S to 38°19.00'S, 149°24.3'E to 149∞27.3'E), 930-951 m, WHOI epibenthic sled, rock/rubble/clay/sand and biogenic sediments, M. Gomon et al. on ORV Franklin, 23 Jul 1986 (stn SLOPE 33), NMV J48813 (1 juvenile).

Remarks. All previous records are from tropical waters. Type material was collected from the Ceram Sea, Indonesia, at depths of 567 and 835 m (Loman, 1908). Subsequent records are from the Kermadec Trench at 2470 m (Stock, 1968), east of Luzon Island the Philippines (*Albatross* Station 5447) at 567 m (Child, 1988) and New Caledonia at 502–570 m (Stock, 1997). Slight morphological variations have resulted in the cautious assignment of all records to this species and prompted Stock (1997: 407) to comment that this species is "apparently of variable morphology." This uncertainty has not been assisted by records of juvenile specimens and the apparent absence of males. Loman (1908) did not mention gonopores and his identification of his ten specimens as female was probably based solely on the absence of ovigers. Should ovigers be absent in both sexes he probably would not have recognised any males had they been present. Stock's (1968) Kermadec Trench specimens differ from other material, notably in the presence of humps on the anterior margin of the cephalothorax, the presence of prominent laterodistal tubercles on the first coxae, in the larger size, in the shape of the abdomen and possession of a heavily sclerotized integument. These specimens were also collected from much deeper water. I agree with Child (1988: 27) that the assignment of the Kermadec specimens to *P. occa* is questionable. The Bass Strait specimen is distinguished by its small size (3.18 mm total length) and the absence of a middorsal tubercle on the fourth trunk segment, a character described by Loman (1908) as a knot-like process and used by Stock (1966a) in his key to separate this species from its congeners. It agrees most closely with the specimens collected east of Luzon I. (Child, 1988:27) with which it shares the more slender proboscis and "slight incipient reticulations" in the integument. As Child made no mention of the absence of a dorsal tubercle on the fourth trunk segment in the Luzon I. specimen, it is presumed to be present. He noted however that the trunk tubercles were more blunt and broad compared to other material and attributed those differences to the immaturity of his specimen. Stock (1997) did not comment on the morphology of the New Caledonian record and no comparison with that specimen can be made. Gonopores and coxal glands not evident, either undeveloped or obscured by the fine reticulations. Glands not evident on the small oral surface. Ovigers are absent. This is yet another specimen provisionally assigned to *P. occa*. Figures are provided to enable future comparison with this specimen.

Distribution. This record extends the distribution from the tropical waters of the Ceram Sea, Indonesia; east of Luzon I. the Philippines and New Caledonia to the temperate waters of southern Australia; 502–2470 m depth.

Pycnogonum (Nulloviger) tuberculatum Clark

Figure 3E–G

Pycnogonum tuberculatum Clark, 1963: 77-79, figs 38 A–D.—Stock, 1994: 68.

Material examined. Vic.WSW of Gabo I., 130 m, trawled, K. Moller on FV *Durraween*, Dec 1929, AM P13690, AM P13691 (female holotype, 2 female paratypes). NSW. 14 mi. off Batemans Bay, 140 m, trawled, K. Moller on FV *Durraween*, no date, AM P13693 (1 female). Tas. 1.2 km E of Cape Boulander, (42°34.'S 148°6'. E), fine bryozoan/shell, 50 m, WHOI epibenthic sled, R. Wilson on RV *Challenger*, 23 Apr 1985 (stn TAS 29), NMV J48814 (1 male).

Remarks. The Tasmanian specimen is in general agreement with Clark's (1963) description and falls within the recorded depth range. Ovigers are absent, placing this species in the subgenus *Nulloviger*. The most significant omission from Clark's description is the presence of two heavy dorsodistal lobes and two dorsolateral digitiform processes on the femora. Clark's fig. 38B also incorrectly shows the presence of a segmentation line between trunk segments 3 and 4. Spines on the tarsus and ventrodistal surface of tibia 2 are considerably more dense and abundant than illustrated by Clark. The prominent dorsal tubercle on the femur is flanked by two low dorsolateral bosses. Coxae 1 and 2 with low distal dorsolateral bosses. Tiny male gonopores are present on the ventral surface of coxa 2 of the fourth pair of legs in all the material examined. Well defined, coxal glands are present on the dorsodistal surface of the second coxae of all legs. Most glands accompanied by a small spine on the proximal margin. A few spinules are scattered around the tip of the proboscis. Oral glands are not evident. *Pycnogonum tuberculatum, P. nodulosum* Dohrn, 1881

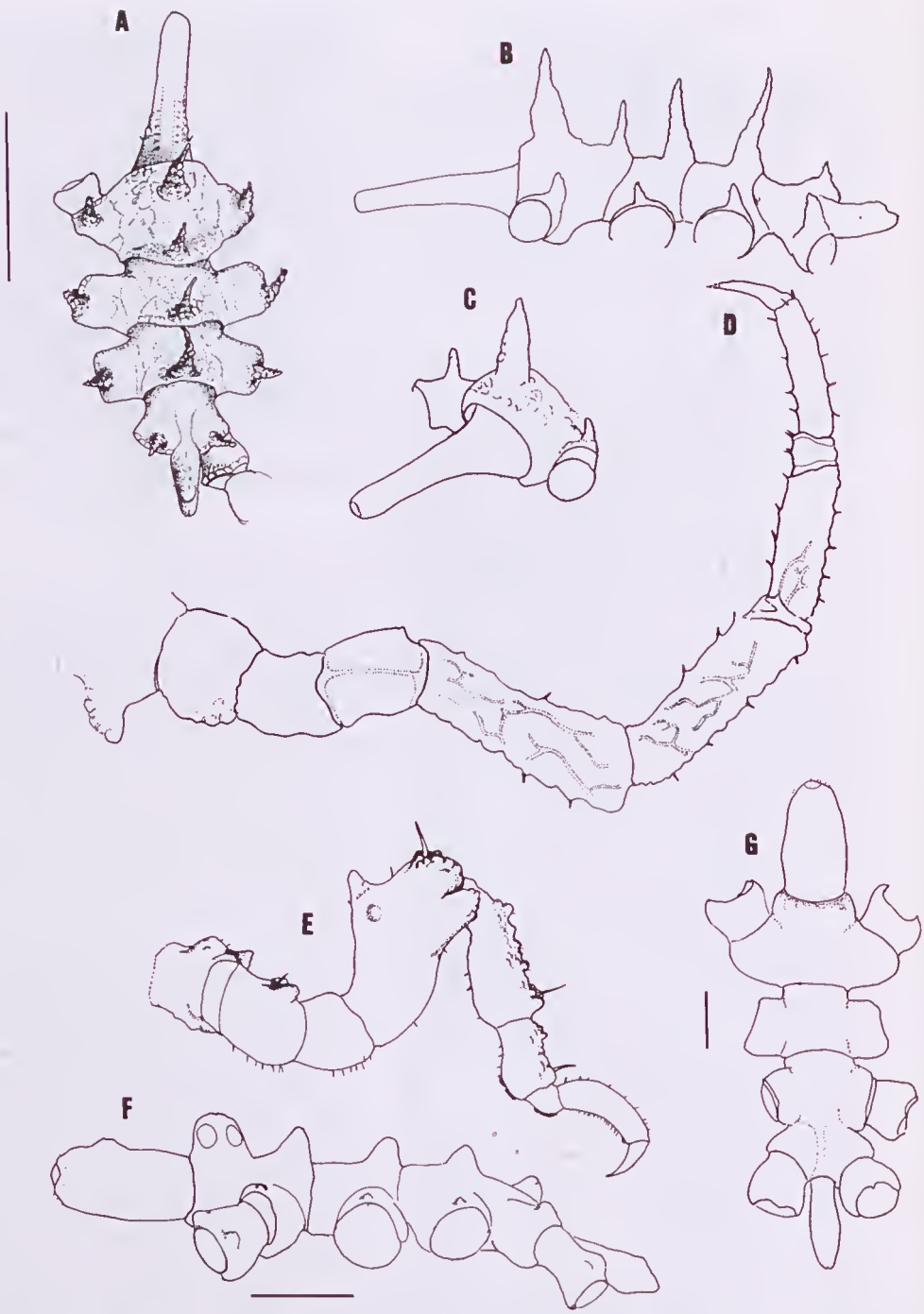

Figure. 3. *Pycnogonum occa* Loman, 1908, NMV J48813 (juvenile). A, trunk, dorsal view. B, trunk, lateral view. C, proboscis and trunk anterior. D, second leg.
Pycnogonum tuberculatum Clark, 1963. NMV J48814 (all figures of male). E, third leg; F, trunk, lateral view. G, trunk, ventral view.

and *P. moolenbeeki* can be distinguished from their congeners by the basal articulation of the abdomen, possession of a single median tubercle on the proboscis and in the general shape of the femur. *P. nodulosum* differs most significantly in the distinct segmentation of trunk segments 3 and 4. *Pycnogonum tuberculatum* is in close agreement with Stock's description of *P. moolenbeeki* with which it shares possession of blunt propodal spines without evidence of bifurcation, the similar distribution of leg spines and the fusion (or partial fusion) of trunk segments 3 and 4. *Pycnogonum tuberculatum* can be distinguished from *P. moolenbeeki* by its larger overall size, shorter proboscis relative to trunk length, longer tibia 2 and more slender propodus. Dorsomedian trunk tubercles appear to be more prominent in *P. tuberculatum* though this may be variable. In the general shape of the femur, *P. lobipes* Stock, 1991 also agrees with these species but otherwise differs in several respects, notably the absence of a median process on the proboscis, the distinct segmentation of trunk segments 3 and 4 and the non-articulated abdomen.

Distribution. Tasmania, Bass Strait, southern New South Wales and north of Papua New Guinea; 1–148 m depth.

Pycnogonum (Nullopycnogon) moolenbeeki Stock

P. moolenbeeki Stock, 1992: 95–97, fig. 11.

Material examined. Timor Sea, Ashmore Reef, Lagoon Patch Reef, near NW entrance, coralline algae and dead coral rubble, 5 m, B.C. Russell, 23 Feb 1981, NTM N9 (1 male).

Remarks. This specimen possesses a number of characters intermediate between *P. tuberculatum* and Stock's description of *P. moolenbeeki*. It agrees with *P. tuberculatum* in possession of prominent dorsomedian tubercles on trunk segments 1–3, complete fusion of trunk segments 3 and 4 and, although the dorsal tubercle in *P. moolenbeeki* appears to be generally less acute, in the shape of the femur. However the smaller overall size (trunk length 1.70 mm, measured from anterior margin of cephalothorax to base of abdomen), the proportionally longer proboscis (42% of trunk), the shorter tibia 1 (53% length of femur) and the more robust propodus align this specimen more closely with *P. moolenbeeki*. The tropical water habitat and depth range 0-5 m are also in keeping with the type locality of *P. moolenbeeki*. Tiny male gonopores pores are present on the ventral surface of coxa 2 of the fourth pair of legs. Oral glands are present. Coxal glands are present on all legs. This record represents a significant extension of range from the Gulf of Oman. The status of this material should be confirmed by re-examination of the type material and comparison with female specimens from the Australian region.

Pycnogonum (Retropycnogon) aurilineatum Flynn

Figure 4A–H

Pycnogonum aurilineatum Flynn, 1919b: 92–95, plate XIII, figs. 1–2; plate XIV, fig. 3.—Stock, 1973: 125.

Material examined. Holotype. Tas. Port Arthur, Mr E. Mawle? 1918?, TM J7/13083 (1 female).

Other material. Vic. Harmers Haven, intertidal, MRG, 18 May 1983, NMV J12936 (1 male, ovigerous.). Shoreham, rocky shallows, M. O'Loughlin, 13 Jan 1981, NMV J12937 (1 female). Flinders, ocean reef, M.P. Marrow, 29 May 1979, NMV J12939 (1 female). Peterborough, intertidal, C. Handreck, 22 Feb.1984, NMV J12941 (1 female). Cat Bay, Phillip I., G.C.B Poore (no date), NMV J12938 (1 female).Torquay, Point Danger, R. Burn, (no date), NMV J12940 (1 female). Lake Tyers, Red Bluff, intertidal, C. Handreck, 12 April 1984, NMV J48816 (1 male).

Distribution Investigator Group, Great Australian Bight, South Australia; SE Tasmania to Coffs Harbour, New South Wales; intertidal to 23 m depth.

Remarks. This species was described from two female specimens. Additional material expands our knowledge of female morphology and enables observations of male characteristics. Flynn accurately described the appearance of the integument as shagreened (as in rough untanned leather) and is comparable to the illustration of *P. elephas* (Stock, 1966a: figs 4a, e). The integument is generally dark brown-black with a characteristic pale middorsal band which runs the length of the first three trunk segments and partially on to segment 4. This character is shared with *P. calculum* Bamber, 1995 and persists in preserved material. Characters that otherwise distinguish these two species are well documented (Bamber, 1995). Distal to an annular constriction around the propodus, the integument is pale. Raised areas with coarse granulation's often have a 'burnished' appearance, being paler in comparison to the surrounding integument. In some (recently moulted) specimens the colour of the integument is lighter or pale pink (Staples, 1999). The pale dorsomedian band usually persists at all stages. The articular membrane at the base of proboscis is wide, when extended it exceeds 25% of the total

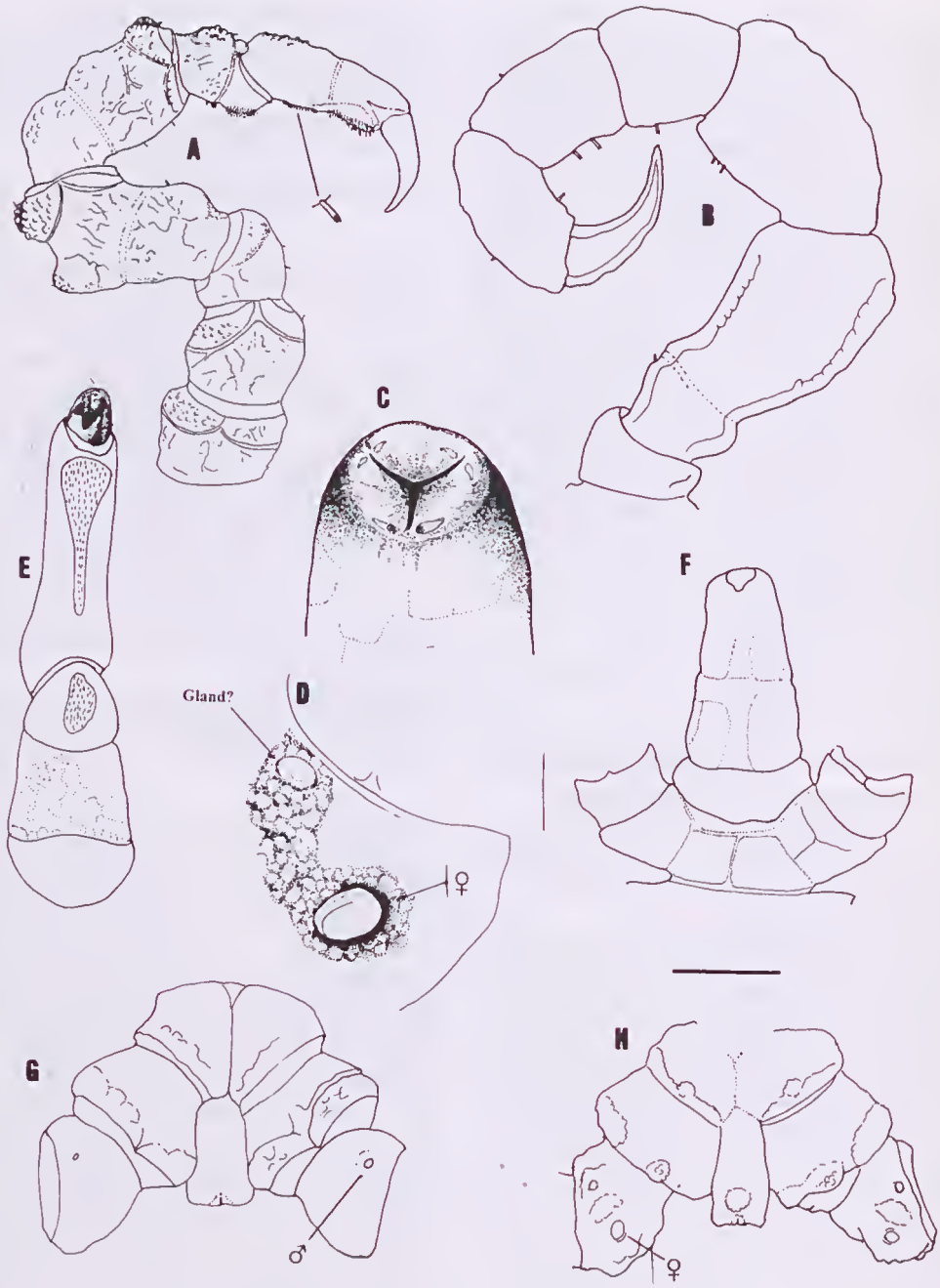

Figure. 4. *Pycnogonum aurilineatum* Flynn, 1919. NMV J12936 A, male third leg. B, male oviger. NMV J12940 C, female mouth showing position of oral glands. D, female, coxa 2 dorsal, detail of coxal gland in relation to gonopore. TM J7/13083 E, female (holotype), distal segments leg 3. NMV J12937 F, female, ventral surface of proboscis and cephalothorax showing articular membrane. NMV J48816 G, male ventral, trunk segment. NMV J12938 H, female dorsal, trunk segment 4.

proboscis length measured ventrally. Oral glands are well defined. Swellings on the legs are variable even within the same specimen, being more acute on some legs than others. The dorsal surface of all leg segments is finely tuberculate with raised areas of the trunk and legs more coarsely granular than the remaining integument. Tiny robust spines are scattered over the trunk and legs. Coxa 1 of all legs has a distal raised shoulder divided middorsally. The femur, tibia 1 and propodus are slightly constricted at one-third to half their length and encircled by what appears to be a broad reticulation line. Dorsodistally the femur and tibiae terminate in a bilobed process with one or two small spines originating between the processes; bilobed processes on tibiae 2 are less pronounced. Ventrodistally, tibia 2 supports a group of about six spines. Small, cleft tarsal spines are numerous, arranged in an irregular oval pattern on an area of light-coloured cuticle. This gives the appearance of the spines being placed on a 'pad' which may be analogous to the "shining patch" recorded in *P. angulirostrum* Stock, 1959. Stock also compared that species to *P. aurilineatum* and illustrated (fig. 9d) what appears to be a similar arrangement of spines. The propodal sole is lined with a dense field of tiny spines arranged in a group which is broad distally, gradually tapering anteriorly towards the tarsus. Female gonopores are conspicuous, placed on the dorsodistal surface of second coxa of the fourth pair of legs and surrounded by raised integument. Coxal glands are present all legs. The surface of the gland is smooth, generally shiny and in some instances transparent.

The smaller male is in close agreement with female holotype. Gonopores are small and inconspicuous, placed on the ventral surface of coxa 2 of the fourth pair of legs. The oviger is 7-segmented, terminating in strong, curved claw. The segmentation line between oviger segments 2 and 3 is not well defined. In the specimens examined, spines on the distal four oviger segments vary in number, those on segment seven, 1 or 3; segment six, 1 or 2; segment five, 1 and segment four, 1, 2 or 3. Most spines have a cleft tip.

Lengths (mm) of male oviger joints are: seg. 1, 0.13; seg. 2, 0.13; seg. 3, 0.37; seg. 4, 0.36; seg. 5, 0.20; seg. 6, 0.26; seg. 7, 0.26; claw 0.27.

Specimens have been recorded in association with solitary corals, corallimorpharians and anemones (Staples, 1997). This species is in close agreement with *Pycnogonum madagascariensis* Bouvier, 1911, redescribed by Arnaud (1971). Arnaud neither illustrated nor discussed the arrangement of the propodal and tarsal spines in detail, however her illustration of the tarsus and propodus in lateral view appear to agree with *P. aurilineatum*. The most notable distinguishing feature appears to be the strongly reticulate integument of *P. madagascariensis* and the absence of a dorsal process on the femur which is present but variably developed in *P. aurilineatum*. In the absence of a record of a male *P. madagascariensis* no further comparison can be made. *Pycnogonum aurilineatum* is the most frequently recorded representative of the genus along the southern Australian coastline.

Remarks

Structures on the oral surface and coxae 2 have are tentatively recognized as glands however histological examination is required to positively establish their function.

Oral glands. Six tear drop-shaped oral glands are recorded in Australian species of *Pycnogonum*. These unpigmented glands are placed around the outer margin of the mouth, one pair at the base of each jaw. These glands may be inconspicuous, particularly in small specimens, and are probably present in all species. The same glands are present but previously not recorded, in the predominantly Northern Hemisphere species *P. littorale* (Ström, 1762), and the Antarctic species *P. gordonae* Pushkin, 1984. Associations between the Pycnogonidae and anemones are well documented, being found inside and outside their host. These glands that may excrete a digestive enzyme breaking down tissue that can be readily sucked into the proboscis.

Coxal glands. In his description of *P. aurilineatum*, Flynn (1919: 93) was of the opinion that "yellowish spots" present on the dorsal surface of coxae 2 were referrable to the pale markings observed on *Pentapycnon charcoti* Bouvier, 1913, which Bouvier thought to be glands. Type specimens of *P. tuberculatum* and *P. moolenbeeki* have been described as females based on the presence of gonopores on the dorsal surface of coxae 2 of all legs. However, re-examination of type material of *P. tuberculatum* and a specimen of *P. moolenbeeki* from northern Australia, shows that while coxa 2 of all legs does possess a dorsal gonopore-like spot, a male gonopore is also present on the ventral surface of coxa 2 legs 4. Either, these species are hermaphroditic, or, the dorsal spots are as Bouvier and Flynn thought, glands. The spots are smooth and shiny and smaller than the typical female gonopore.

Although in some specimens these spots are more clearly defined, there appears to be no disruption of the integument. For these reasons I believe the spots more likely to be glands than gonopores but whether they are a form of cement gland or serve some other function has not been determined. As with the gonopore, each gland is usually accompanied by a tiny spine on its proximal margin.

Gonopores. In the genus *Pycnogonum*, gonopores vary in number and placement. Gonopores have been recorded on the dorsal and ventral surface of coxa 2 of all legs, dorsal and ventral surface of the fourth pair, ventral surface of legs 3 and 4, or the ventral surface of the third pair only. The most common arrangement is for female gonopores to be on the dorsodistal surface of coxa 2 of leg 4 and for the smaller, less conspicuous male gonopores to be located ventrally. These positions are consistent with the observed reproductive strategy of *P. littorale* (King,1973: 72) and *P. aurilineatum* (Staples, 1999: 317) in which the gonopores of both sexes are opposed during the transfer of eggs. The placement of the male gonopores on the ventral surface of coxa 2 of leg 4 appears to hold true for all Australian species but due to absence of material and possible confusion with coxal glands, the number of female gonopores is uncertain. Gonopores in *P. aurilineatum, P. clarki* and *P. carinatum* are confined to legs 4; the male gonopore ventral and female dorsal. The possible presence of gonopores on the ventral surface of the legs 4 in the holotype of *P. torresi* raises the possibility that this specimen also shares these characters.

Should my conclusion be correct, *C. moniliferum* Stock, 1991 from New Caledonia appears to be the only remaining species described as having female gonopores on the middorsal surface of coxa 2 of all legs. Re-examination of the type material is required to verify the number of gonopores in that species.

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